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PLANT SUCCESSION ON EXPOSED GRANITE OF ROCKY FACE MOUNTAIN, ALEXANDER COUNTY, NORTH CAROLINA

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The establishment and development of vegetation on bare granitic rock has been described for two contrasting situations in North Carolina (Oosting and Anderson 1937, 1939): one on a cliff in mountainous Jackson County and the other on level rock outcrops in the lower Piedmont near the fall line in Wake and Franklin Counties. On such exposures, where soil and moisture are scarce or completely lacking, most plants are unable to exist. A few, however, can find anchorage and survive in the minute crevices of bare rock. These pioneers, by decomposition and by holding transported mineral and organic matter, form thin mats on which other plants can grow. While invaders appear near the center of the mats where accumulated soil is deepest, the pioneers advance on bare rock around the edges.

Somewhat circular mats result which support concentric girdles of different plants. Pioneers are always at the periphery and succeeding girdles are made up of plants requiring progressively more soil or moisture. The latest invaders are thus always near the center. Theoretically the mats could expand to cover an entire rock exposure and they may deepen until the succession of invaders terminates in a community similar to that of the surrounding territory.

About halfway between the outcrop in the Blue Ridge and those in the lower Piedmont lies Rocky Face, a small mountain in the upper Piedmont with large areas of exposed granite (fig. 1). Much of the rock surface is gently sloping, or nearly as flat as the fall line outcrops; some of it is very steep like the cliff in Jackson County. The first objective of this study was to determine successional sequences on the exposed granite of Rocky Face Mountain and to make comparisons with those found in the mountains and in the lower Piedmont. The major vegetation on the shaded, cooler north-facing slope of Rocky Face differs, as would be expected, from that of the other sunnier slopes. There was, then, the added opportunity for comparing succession on shaded northern exposures and sunny southerly exposures of bare rock.

The mountain and its history. Rocky Face, which is located near Hiddenite in Alexander County, lies about 5 miles south of the main group of the Brushy Mountains, a small, independent range, which extends east

from near Lenoir to Pilot Mountain. The main portion of Rocky Face is an elongated, dome-shaped mass, rising about 600 feet above the surrounding country to an elevation of 1840 feet and extending about one mile from northeast to southwest. Its southwestern end terminates in a low rounded spur.

On the eastern, western, and southern slopes are large exposures of rock which are bare except for mosses, lichens, and small mats of vegetation on very thin soil. On the north there are two barefaced cliffs. The top of the mountain and the north side, except for the two outcrops, are well wooded.

FIG. 1. Southern-side of Rocky Face Mountain showing large areas of exposed rock.

The bare areas offer a wide variety of slope as well as exposure. The cliffs on the north side are both very steep, at some places being nearly vertical. The outcrops on the east and south sides are mostly gentle slopes, ranging from less than 20 to as much as 60 degrees.

The rock is biotite granite gneiss (Watson and Laney 1906) of light grey color and medium texture, made up of alternating dark and light bands. The darker bands contain most of the black biotite, and the lighter-colored ones consist chiefly of quartz and feldspar.

Climatic conditions on Rocky Face are similar to those of the upper Piedmont of North Carolina, although the altitude and exposure must result in greater extremes. The annual mean temperature recorded by the Weather Bureau at Statesville, only 20 miles away but 900 feet lower than the crest of Rocky Face, is 59.1° F, with a mean of 41° in January and 77.6° F in August. The mean annual rainfall of 44.88 inches is well distributed throughout the year and ranges from 2.4 inches in November to

5.9 inches in August. Records for the mountain would differ somewhat but these are indicative of the general situation.

Man has disturbed the natural vegetation on Rocky Face but little. More than 85 years ago, 15 or 20 acres of the gentle slopes on top of the mountain were cleared for cultivation but these fields were abandoned in 1902 when a quarry company bought most of the area. Between 1902 and 1921 some chestnut oak and pine were cut. Most of the lumber was taken out by way of a wagon road up a western ridge, but some of the logs were rolled down the south and east sides of the mountain. It is quite likely that many mats of vegetation, which are usually poorly anchored, may have been dislodged and carried down with the logs. There has been no lumbering since 1922 when the mountain was sold to the Hiddenite Quarry Company.

The mountain proper has not been disturbed by quarrying, for the companies which have owned it have operated only on the lower spur. There have been occasional fires over the entire mountain, but none on the south side within the past 20 years. Fire-scarred trees and partially burned logs on the north and east exposures are evidence of more recent fires there.

Kinds and nature of succession. Sunny exposures. Many of the exposures include areas which are never shaded. These lie on the eastern and southern side of the main mountain and the spur, and on the western side of the spur. All of these exposures present the same kind-of situation and have the same types of vegetation and mat development.

Succession here usually starts on bare rock, but it occasionally may be initiated on thin layers of sandy soil which accumulates in shallow depressions on the rock surface. These two lines of succession differ greatly in the initial stages, but finally lead to the same type of mat.

Bare rock phase. Pioneers. On these hot, dry rocks there are several crustose lichens which are able to withstand desiccation and grow without soil. One of the most prominent of these is the tiny *Staurothele diffractella* (Nyl.) Tuck.[1] which grows so closely appressed to the rock surface as to seem almost a part of it and often gives the light grey granite a smutty black appearance (fig. 2). *Peccania kansana* (Tuck.) Forss., a slightly larger, brown crustose lichen is occasionally found on rough or damp surfaces. These crustose lichens may have some corrosive effect on the granite but there is no evidence that it is enough to be a factor in permitting other plants to follow. *Parmelia conspersa* (Ehrh.) Ach., a grey-green foliose lichen, also grows on bare rock, forming circular patches which often cover and destroy *Staurothele*. Although *Parmelia* is larger and holds more mois-

[1] We acknowledge with appreciation the identifications of Cladoniae by Dr. Alexander Evans, Yale University, and of other lichens by Dr. Edward C. Berry, Missouri Botanical Garden. All photographs of vegetation are by L. H. Lyon, Statesville, N. C.

ture than the crustose lichens, there is no evidence that it contributes to mat building or succession.

The first pioneer that shows definite evidence of soil building and consequent succession is *Grimmia laevigata* (Brid.) Brid., and rarely *Grimmia pilifera* Beauv. These mosses commonly appear on rock surfaces which support no lichens, and at first, are tiny scarcely visible scattered tufts. This is well illustrated in figure 2. The black tufts are *G. laevigata*, the greyish-appearing, smooth splotches are *Staurothele diffractella*, and the more or less circular foliose patches, some with whitish margins, are *Parmelia conspersa*. Note that the majority of the small tufts of *Grimmia* appear on the whitish rock surface which is completely devoid of lichens. Figure 3 shows that

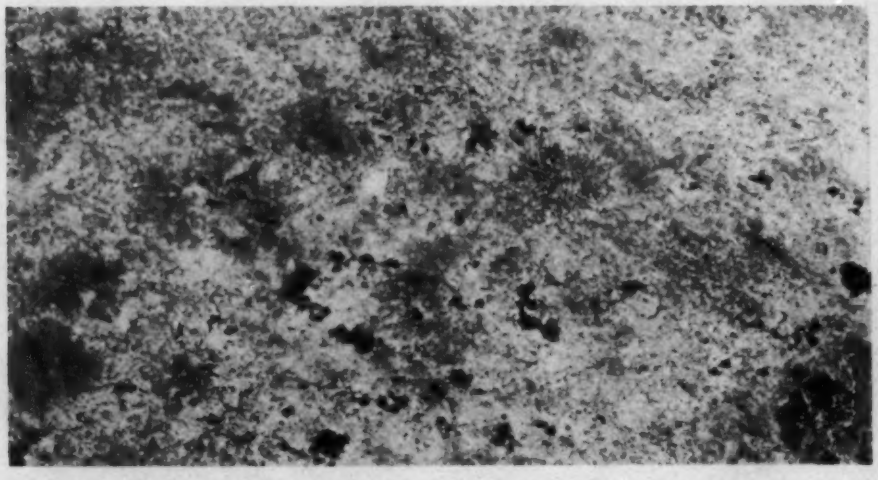

FIG. 2. Pioneers on bare granite. Black dots and tufts are *Grimmia;* grey, smooth splotches, *Staurothele;* patches of foliose lichen, *Parmelia.* Note that most of the *Grimmia* starts directly on bare rock.

these tufts, originating on bare rock readily expand and develop, regardless of the presence of crustose lichens. The tufts gradually enlarge to form irregularly distributed patches which may eventually meet to form a compact carpet-like cover over large areas.

Soil, transported by wind and water, lodges in the developing mats of *Grimmia*, often burying all but the mosses' tips. The uncovered tips continue to grow while the buried portions die and add humus to the collecting soil. Such mats may become three inches deep which is more than sufficient to permit establishment of rooted plants. However, very few species can meet the conditions for invasion. It is probable that the extremely compact surface of the mats inhibits the establishment of seedlings of rooted plants.

Early invaders. Extensive areas of sunny rock surface are nearly

covered with Grimmia carpets unbroken by the presence of other plants. At the margins of the mats two small succulents sometimes may be found (*Diamorpha cymosa* (Nutt.) Britt. and *Talinum teretifolium*[2]). These are present only where sand has washed in and they play no part in succession. Although the Grimmia mat may be of long duration, it is eventually invaded by other species and then succession proceeds relatively more rapidly.

A coarse, creeping club moss (*Selaginella rupestris*) is locally effective in breaking through the Grimmia mats (fig. 4), its long slender roots pene-

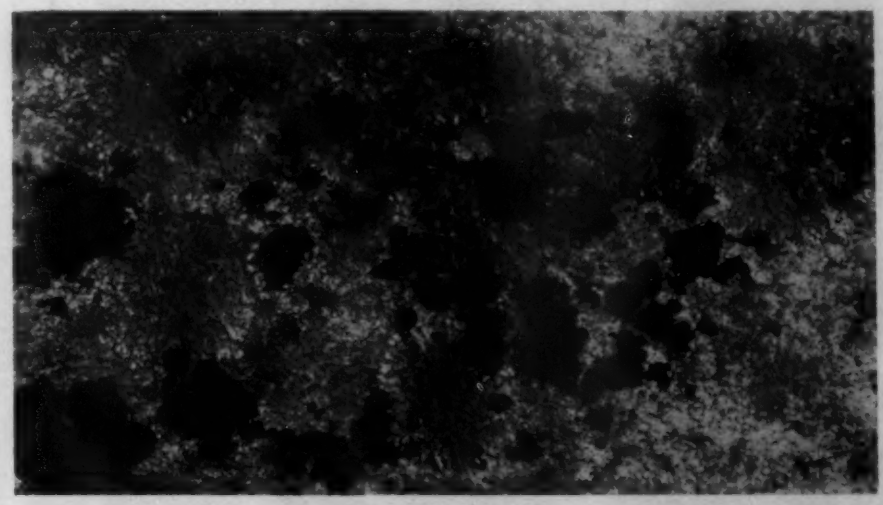

FIG. 3. Initiation of mat development on a sunny exposure with tufts of *Grimmia* growing on bare rock. Note *Parmelia* growing on *Grimmia* and vice versa.

trating to the underlying soil. Since *Selaginella* grows from the tips and decays below, its coarse bulk adds much to the thickening mat. Eventually it forms a solid cover under which *Grimmia* dies and in which other plants readily become established. The Grimmia-Selaginella stage (fig. 5) is also developed in thin sandy depressions through a quite different successional sequence. Since later stages are identical, the early stages on thin soil will be considered next.

Thin soil phase. In general, all soil is washed down the mountain from the rock exposures except when held in mats. But, on the extensive slopes of the southern and eastern exposures, there are a few localized situations where some mineral soil may be retained. Exfoliation may leave flat terraces, several feet wide, which slow the moving water and cause some of

[2] Nomenclature for vascular plants is that of Gray's Manual, 8th edition, unless authorities are given.

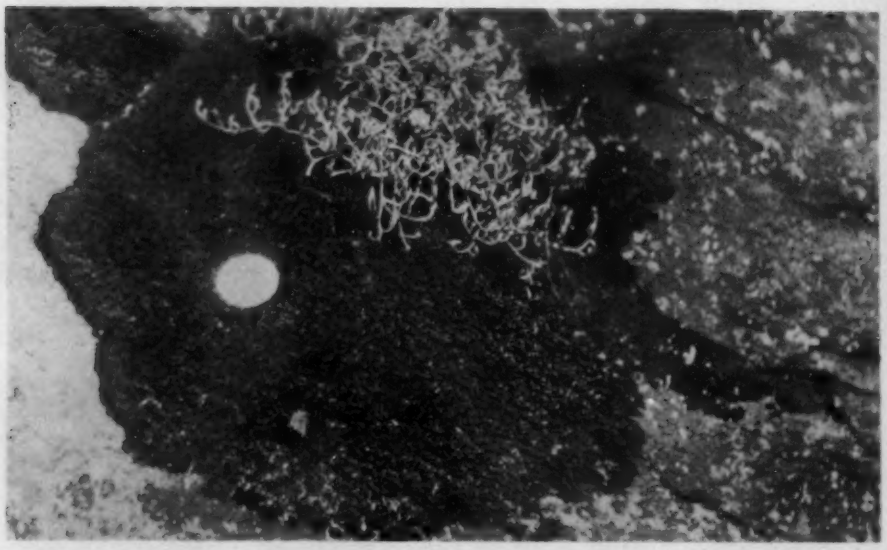

FIG. 4. *Selaginella rupestris* invading a small Grimmia mat (note coin). Single plant of *Talinum* at upper edge of mat where sand has washed on *Grimmia*.

the soil to be deposited. Thin layers of mineral soil also accumulate behind the scattered rock slabs and in shallow depressions. Moisture conditions in these situations vary widely. Following rains, water may stand for a

FIG. 5. Mats in which *Selaginella* has almost covered *Grimmia* which shows only as a narrow dark peripheral margin. Herbs in center of mat: *Hypericum, Tradescantia, Opuntia, Allium.*

time and when it evaporates, the soil is left baked hard and about as dry as the rock surfaces. Few plants can survive such extremes of moisture conditions.

Pioneers. Two succulent vascular plants, *Diamorpha cymosa*, an annual which is extremely abundant in spring and conspicuous because of its bright flesh color, and *Talinum teretifolium*, a perennial, come in on the bare, thin sand of the depressions and rarely anywhere else. Although they may hold the sand from washing and may likewise cause some transported material to be deposited, they themselves have no appreciable effect on mat building.

The first mat-former on thin, sandy soil is the moss, *Campylopus flexuosus* Brid.[3] which grows in round green tufts among the plants of

FIG. 6. *Campylopus flexuosus* and *Cladonia* spp. growing in shallow depressions. Organic material from decaying log and other sources contributes to abundance of lichens. *Opuntia*, at edge, is on washed-in soil.

Diamorpha and *Talinum*. The moss adds organic matter, holds mineral soil, and as it increases, slows evaporation of water. With its establishment, conditions favor other invaders.

Mat builders. Several lichens of the genus *Cladonia* often appear at this stage, growing with and on *Campylopus*. Being large bulky plants, they increase the depth of mats by providing decaying organic matter and accumulating mineral soil (fig. 6). At almost any stage just preceding or with fruticose lichens, *Opuntia humifusa* may appear on the thin margins of mats, and once established, remain indefinitely (figs. 5, 6, 7). Succession is accelerated when the lichens are present but it may proceed without them.

[3] Used in a broad sense to include *C. tallulensis* Sull. & Lesq.

Abundance of the lichens appears to be correlated with the amount of organic matter in the soil.

Cladonia rangiferina (L.) Webb. is associated with *Campylopus* more regularly and abundantly than any other lichen, but *C. sylvatica* (L.) Hoffm., *C. sylvatica* f. *setigera* Oxner., *C. tenius* (Floerke) Harm., and *C. apodocarpa* Robbins may also be present. The Cladoniae are so abundant in some mats that they nearly destroy the *Campylopus* under them.

Whether the lichens are present or absent, the next plant of importance in succession is *Polytrichum commune* Hedw. The spores germinate directly on *Campylopus* and soon *Polytrichum* dominates the center of the mat. While this is taking place, *Campylopus* and its associates are advancing on thin soil at the edge of the mat.

FIG. 7. Mat in early herb stage but showing successive girdles of (1) *Campylopus* and associates, (2) *Polytrichum*, and (3) *Hypericum* and grasses.

While Cadoniae are more commonly associated with the *Campylopus* girdle, several species frequently grow with *Polytrichum*. They are *C. caroliniana* (Schwein.) Tuck. (typical form), *C. leporina* E. Fries., and *C. uncialis* (L.) Web. The increase of *Polytrichum* and its associates adds greatly to the depth of the soil until the Campylopus-Polytrichum mats are similar in depth and condition to the Grimmia-Selaginella mats of bare rock. The same herbs begin to appear on both types of mats, and from this point, succession on all mats of the sunny exposures continues along the same line.

Major trend. Herb stage. No single herb species greatly influences the future development of the mats, but collectively they increase the depth of the soil with decaying organic matter. Many herbs that are found on

young mats also grow in adjoining fields and woods. Some, however, reach their best development on the still relatively thin soil on the rocks. *Opuntia humifusa* is one of these (figs. 5, 6, 7). *Hypericum gentianoides,* a coarse annual which occasionally grows in the surrounding areas, is one of the earliest and most abundant inhabitants. *Saxifraga michauxii,* almost never found in deep soil, grows along the lower edge of the mats, especially where some seepage takes place. Once these early herbs are established (fig. 7), they are soon followed by a dense growth of any of the following drought-tolerant plants:

Allium cuthbertii Small
Cheilanthes lanosa
Coreopsis tripteris
Crotonopsis elliptica
Danthonia spicata
Heuchera americana
Linaria canadensis
Panicum lanuginosum var. *fasciculatum*
Bulbostylis capillaris
Tradescantia ohioensis

The following plants of surrounding fields and woods are often present in the late herb stages on the mats:

Andropogon elliottii
A. virginicus var. *abbreviatus*
Diodia teres
Houstonia caerulea
Hypericum denticulatum
H. punctatum
Krigia virginica
Parthenocissus quinquefolia
Pycnanthemum incanum
Senecio smallii
Sericocarpus linifolius
Tradescantia virginiana
Yucca filamentosa

These herbs, each adding a small amount of organic matter, increase the bulk of the mat and its water holding capacity. Mineral soil that washed down from above is caught by the living and dead plants until mats in this stage are sometimes as much as six or seven inches deep.

Shrub stage. On the sunny slopes there is often no shrub stage; the trees follow immediately after the herbs. *Callicarpa americana, Rhus glabra, Chionanthus virginicus, Oxydendrum arboreum,* and *Asimina parviflora* appear before trees where much mineral soil has collected, but rarely occur on shallow organic mats. There *Juniperus virginiana* and *Pinus virginiana* are the first and often the only woody plants to invade. The growth of these trees on mats for the first few years is almost as great as the growth of the same species on soil nearby. As the young trees increase in size and their moisture requirement becomes greater, their rate of growth decreases.

Borings of seven *Pinus virginiana* trees growing on mats showed an average age of 31 years with an average d.b.h. of 6.69 inches. Four of these pines growing on soil on top of the mountain had the same average age as the mat trees and an average d.b.h. of 9.1 inches. A 100-year old *Juniperus*

virginiana found growing on a mat had a d.b.h. of seven inches, while one with the same diameter growing on deep soil at the foot of the mountain was only half as old. Insufficient moisture undoubtedly results in the slow rate of growth, but the poor anchorage in mats which break loose limits the age of trees. Several pines 75 years old were found anchored among rock slabs but none over 45 years were found on mats without other anchorage. Uprooted trees are common on all parts of the mountain.

Mature mats. Many new invaders appear in the more favorable habitat under the trees. They are of little importance in further development of the mats, although they do add to the depth of the soil. The two groups of plants most common here are Cladoniae and mosses. Species of large coarse

FIG. 8. Mature mat on sunny exposure showing partially dead pine trees in center, bordered by successive girdles of *Andropogon*, lichens, and mosses.

Cladoniae are often so abundant under trees as to form thick grey-green carpets which nearly obscure other small plants (fig. 8). They are: *Cladonia rangiferina, C. sylvatica* f. *setigera, C. tenuis,* and *C. apodocarpa.* Several other species of *Cladonia* grow on the partially decayed organic matter under the trees but are of little consequence in soil building because of their small size. They are:

Cladonia bacillaris (Ach.) Nyl., *C. cristatella* f. *beauvoisii* (Del.) Vainio, *C. cristatella* f. *vestita* Tuck., *C. piedmontensis* f. *squamulosa* Robbins, *C. grayi* Merill f. *simplex* Robbins, *C. grayi* f. *carpophora* Evans, *C. squamosa* (Scop.) Hofm.

Mosses commonly found on soil in shady woods are regularly present under the trees in mature mats. These include: *Atrichum angustatum*

(Brid.) Bry. Eur., *Dicranum fuscescens* Turn., *D. scoparium* Hedw., *Leucobryum glaucum* (Hedw.) Schimp.

Other mosses grow in the seepage areas below the mats. The thick organic mats absorb much water during rains. As the water passes downward and is stopped by the solid rock, it seeps out along the lower edge. This seepage often continues for days. Here only are found the mosses that usually grow in wet places: *Philonotis fontana* (Hedw.) Brid., *Bryum pseudotriquetrum* (Hedw.) Schwaegr., *Sphagnum compactum* DC.

Mats in the mature stage (fig. 8) are probably little changed over long periods of time. They advance over the surrounding rock very slowly, but without some anchorage to prevent the inevitable uprooting of the trees, they probably will never cover all of the bare rock on the mountain.

Shady north slopes. The two rock outcrops on the north side of the mountain present a somewhat different situation from the extensive areas of bare rock on the other exposures. In general, the slope is much greater. Except for a smaller area near the top, the slope is more than 45 degrees, and in some places, nearly vertical. As a result, these steep, north-facing slopes are shaded a large part of each day and are cooler and moister than those of any other part of the mountain. All vegetational development here must start from bare rock, since there are no depressions or flattened areas where soil may accumulate.

Pioneers. Although the fundamental mat builders of the two exposures are different, all the rock pioneers of the sunny areas are at least present on the north slopes. *Staurothele diffractella* and *Parmelia conspersa* are present as on the other exposures, but do not cover large areas. *Umbilicaria pustulata* (L.) Hoff., a large foliose lichen sometimes seen on shaded bare rocks on the south side, is abundant on the steepest north slopes. *Grimmia laevigata* and *Grimmia pilifera* are both present in small scattered patches which never converge to form the extensive carpet-like cover they do in the sun. *Andreaea rothii* Web. and Mohr., a moss not found on the sunny slopes, is present here growing in small scattered patches on bare rock. Neither *Grimmia* nor *Andreaea* form patches large or abundant enough to be of any importance in succession.

The bare rock pioneers which definitely initiate mat formation are *Rhacomitrium heterostichum* (Hedw.) Brid. var. *ramulosum* (Lindb.) Jones and *Hedwigia ciliata* Hedw., two pleurocarpus mosses that cling to the steep rocks in stringy mats (fig. 9). Pine needles and other organic materials from the woods above and around the outcrops slide down the steep slopes and lodge on the upper side of the moss mats to form banks which are often several inches deep. The decaying organic materials and mineral soil they collect encourage further mat formation.

Mat builders. Cladoniae are much more prominent in mat building

here, where the supply of organic matter is greater, than on the south slopes. *Cladonia caroliniana* f. *dilatata* and *C. uncialis* are almost always present on the organic accumulation above *Rhacomitrium* and *Hedwigia*. *C. tenuis, C. sylvatica,* and *C. rangiferina* are present occasionally.

The lichens add so much decaying organic matter and collect so much mineral soil that the heavy mats in this stage are often washed down the slopes. Sometimes they lodge behind more firmly anchored mats, sometimes they land at the bottom of the cliff. Mats on roughened rock may be anchored firmly enough to hold their own weight as well as that of mats sliding down from above and thus continue to increase in size and depth.

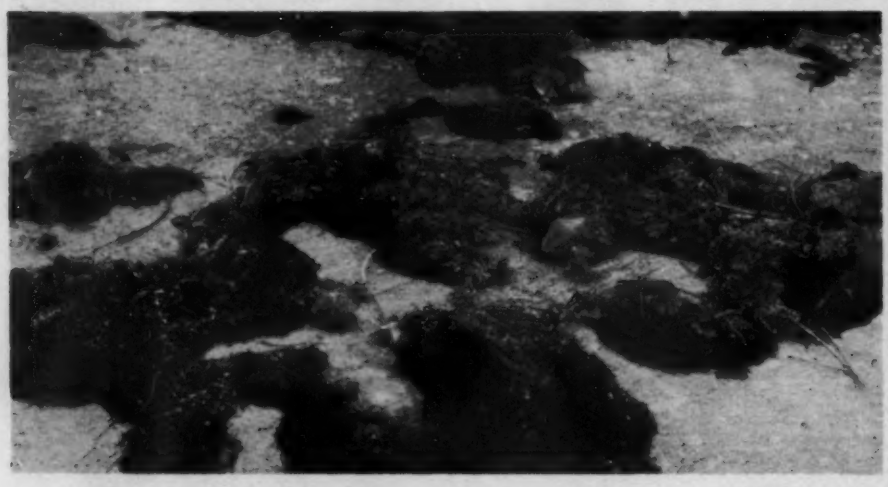

FIG. 9. Pioneer stage in mat development on shady north slope. *Rhacomitrium heterostichum* and *Hedwigia ciliata* growing on bare rock and loose pine needles and lichens forming banks on upper edge of mats.

Polytrichum juniperinum Hedw. appears on the deepening mats and grows so abundantly that the pioneer mosses and lichens are seen as only narrow girdles on the lower side. *Saxifraga michauxii* usually grows in the lichen and moss girdles where some seepage occurs. The Polytrichum mats are soon invaded by herbs.

Herb stage. The number of species of herbs that grow on young mats is much less on the north slopes than on the south. These few species, however, grow densely and aid in soil building just as much as the larger number of species on the other side. The first herbs to appear are two grasses, present but less abundant on the south slopes, *Panicum lanuginosum* var. *fasciculatum* and *Danthonia spicata* (fig. 10). These grasses, with *Coreopsis major* and *Sericocarpus asteroides,* which soon follow them, are the only herbs growing on the young mats before shrubs appear.

Shrub stage. Although shrubs do not necessarily occur in the successional sequence on sunny slopes, there is no question of their successional importance on the north side. Here shrubs appear on relatively young mats and never completely lose their dominance. *Robinia hispida, Chionanthus virginicus, Rhus copallina,* and *Polycodium candicans* Small may appear with the earliest herbs (fig. 11). The two important shrubs in mature shrub stages are *Kalmia latifolia* and *Rhododendron catawbiense* which form tangled masses on the largest mats on the north slope. Two other tall shrubs,

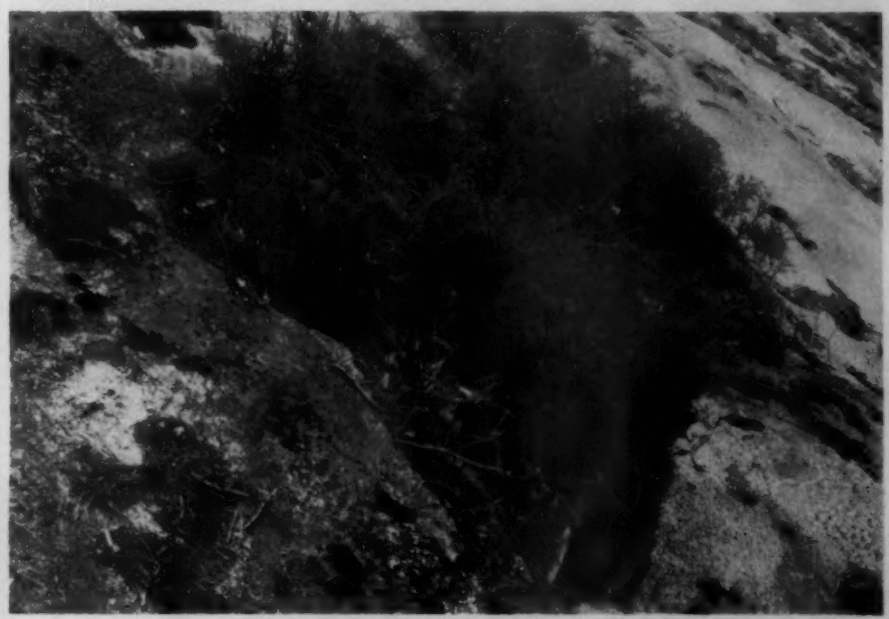

FIG. 10. Shady-side mats with girdles of Rhacomitrium-Hedwigia, Polytrichum, and herb (grasses) stages.

Prunus serotina and *Sassafras albidum,* frequently appear before or with *Kalmia* and *Rhododendron,* survive competition, and occur occasionally as small trees on older mats.

Mature mats. There are now no living pine trees on the north side mats, but there are several standing dead pines whose trunks show fire scars. They may be either *Pinus virginiana* or *P. pungens,* for both species are found on the mountain. One pine with no anchorage except the soil of a mat had a d.b.h. of 12.8 inches and an approximate age of 60 years. This shows faster growth than any measured on the sunny exposures. There are many uprooted and partially burned pines at the foot of the cliff.

There are few pines in the hardwood forest that covers a large part of

FIG. 11. North-side mats with first shrubs. The successive girdles are Rhacomitrium-Hedwigia, *Polytrichum*, herbs, and shrubs (mostly *Chionanthus*).

the north side of the mountain. If succession on the mats should continue it would probably result in hardwood dominance similar to that of surrounding forest whether or not the pines were uprooted by storms or

FIG. 12. Shrub dominance on north side mats. Note dead and fallen pines.

destroyed by fire. The presence of *Prunus serotina* and *Sassafras albidum*, which elsewhere often grow to be large trees, indicates a step in that direction (fig. 12).

The following plants found growing on mature mats may also occur in the stable surrounding areas:

Dicranella heteromalla (Hedw.) Schimp.
Leucobryum glaucum (Hedw.) Schimp.
Cheilanthes lanosa
Chrysanthemum leucanthemum var. *pinnatifidum*
Corydalis sempervirens
Dryopteris marginalis
Epigaea repens
Houstonia longifolia
Houstonia tenuifolia
Lonicera japonica
Polygonatum biflorum
Scutellaria serrata
Senecio smallii
Smilax glauca
S. rotundifolia
Spiraea corymbosa

Several plants found in seepage areas below lower margins of woods on the slope, also occur where there is seepage from mats:

Bryum pseudotriquetrum (Hew.) Schwaegr.
Philonotis fontana (Hedw.) Brid.
Scapania nemorosa (L.) Dum.
Sphagnum compactum DC.
Thuidium delicatulum (Hedw.) Mitt.

Discussion. Comparison of sunny and shady exposures of Rocky Face. Successional development on bare rock on Rocky Face follows the same general pattern everywhere, but there is considerable difference in the dominant species on the southern and northern exposures. In addition to exposure, the basic habitat difference is the steepness of the north slope. Since general climatic conditions must be relatively uniform on so small a mountain, the differences in species must be controlled by microclimatic variations related to exposure and degree of slope. Precipitation is probably nearly the same on all exposures, but temperatures are always lower and evaporation is much less on the north slopes than on the sunnier portions of the mountain. The cooler, moister conditions permit the growth of certain species and restrict the growth of others. The steepness of the north facing rocks excludes some plants of the gentle southern slopes because of the limited anchorage and absence of sandy depressions.

The same species of pioneer crustose and foliose lichens grow on the rocks of both exposures but in neither case do they play any part in succession or mat-building. The first plants in each situation that initiate succession are mosses, but the species differ. *Grimmia*, which is definitely the pioneer mat-builder on rock surfaces of the sunny areas, is present on the shaded north slopes, but plays little part in mat-building. *Campylopus*,

the initiator of succession on thin layers of mineral soil on the sunny slopes, is not even present on the north side. *Rhacomitrium*, the dominant mat-builder of the north side was not found at all on the sunny exposures.

Both *Rhacomitrium* and *Andreaea* are northern mosses which range southward along the mountains to Georgia and Alabama. *Campylopus*, on the other hand, is essentially southern and grows here almost at the northern limit of its range. This same north and south slope delineation is evident in the secondary invader, *Polytrichum*. On the south slope it is *P. commune*, which invades Campylopus or Campylopus-lichen mats in depressions. On the north slope, however, the corresponding invader is *P. juniperinum*. *P. commune* is a wide-ranging species, found from the artic to the tropics; *P. juniperinum*, on the other hand, is a more northerly species. It is worthy of note that *P. piliferum* Hedw. is associated with *P. juniperinum* in the Selaginella-Polytrichum mats of exposed peaks near the North Carolina-Virginia line, but is completely absent on Rocky Face.

The shrubs on the mats of the north slopes are successionally much more important than they are on the sunny mats. They appear earlier and maintain dominance for long periods in the damper, cooler environment than they do on the dry, sunny exposures where they rarely hold a truly dominant position. Because of the early appearance of the shrub stage, herb dominance on the shaded areas is shortened.

The general vegetation of the wooded areas on the two exposures of Rocky Face differs in the species of plants present. The vegetation on mature mats on the sunny parts of the mountain resembles that of the wooded areas on those exposures while the plants on the mature mats of the north slopes are much like those found in the woods on that side.

Comparison of Rocky Face with other North Carolina outcrops. One of the purposes of this study was to compare the trends of succession on Rocky Face with those of the cliff in mountainous western North Carolina and the granite exposures along the fall line in the eastern part of the state. The northern slopes of Rocky Face show many similarities in habitat factors, in general patterns of succession, and in species of plants, with those of the barefaced cliff in western North Carolina. Also there are many such similarities between the sunny exposures of Rocky Face and the eastern North Carolina situation.

In every instance, the first plants to appear on rocks are crustose and foliose lichens, but in no place are they found to be essential to further plant development. The pioneers which initiate succession invariably are mosses, which are followed in turn, as the depth of the soil increases, by herbs, shrubs, and trees. Most of the species comprising these stages differ in the three localities, and as succession proceeds, the dominants tend to approach the general vegetation of the region.

Only a few species are found in all three situations. These include the two lichens, *Parmelia conspersa* and *Cladonia tenuis*, and *Juniperus virginiana*. Although the species are not the same, a representative of the moss genus *Polytrichum* is one of the early mat-dominants in each locality. *Krigia virginica* and *Leucobryum glaucum* have such a wide distribution that it is not unexpected that they should occur in all the places studied.

Northern Rocky Face and the cliff in western North Carolina. The barefaced western cliff lies at an altitude approximately 2000 feet higher than Rocky Face and has a much greater and more evenly distributed rainfall. The outcrops in both situations are steep slopes unbroken by crevices or boulders.

In general successional pattern, and even in species of plants present, there are many similarities in the two situations. The moss, *Rhacomitrium heterostichum* var. *ramulosum*, is the pioneer mat-former and initiates succession in both places. *Hedwigia ciliata*, although playing a more important successional role on Rocky Face, is present on both outcrops. A species of the moss *Andreaea* is represented in both situations, *A. rupestris* Hedw., successionally important on the western cliff, and *A. rothii*, merely present on Rocky Face. Both species of *Andreaea*, at lower altitudes, are restricted to rather special seepage zones. If there is too much seepage, *Andreaea* is excluded by the profuse growth of much weedy species as *Sematophyllum carolinianum* (C. Muell.) E. G. Britton and *Hygroamblystegium orthocladon* (Beauv.) Grout. On areas where seepage is intermittent and not excessive, *Andreaea* may be the pioneer. This is the situation in figure 10 where the several dark patches, below and beside the large mat, show *Andreaea* established and initiating succession on bare rock in intermittent seepage areas. At higher altitudes, where rainfall is greater and evaporation ratios are more favorable, its occurrence is influenced less by seepage and it is a more important pioneer.

Lichens contribute to succession similarly in both localities but there are more differences than similarities in species represented. Of the eleven species reported from the western cliff and the nine found on northern Rocky Face, only three species, *Cladonia rangiferina*, *C. strepsilis*, and *C. tenuis*, are duplicated.

Saxifraga michauxii, although of little aid in the progress of succession, is prominently present in both places. In the herb stage the following plants are dominants in both situations: *Danthonia spicata*, *Panicum lanuginosum* var. *fasciculatum*, and *Coreopsis major*. Several other plants, of little importance, are represented at some time or another on both outcrops. They are: *Polygonatum biflorum*, *Krigia virginica*, *Dryopteris marginalis*, and *Thuidium delicatulum*.

The shrub stage on both outcrops is dominated by *Kalmia latifolia* and

Rhododendron catawbiense. *Prunus serotina* and *Chionanthus virginicus* are present in both situations.

Similarities in the large trees of the two places are not marked, for those of the western cliff are representative of the high mountains hardwood forest of that section, and the trees of north Rocky Face are like those of the isolated low mountains of the neighboring Piedmont (Williams and Oosting 1944).

Sunny exposures of Rocky Face, and Granite Rock in eastern North Carolina. The general climatic conditions of Rocky Face are similar to those of the fall line outcrops. The annual rainfall of the two places is about the same. Rocky Face generally, is probably a little cooler than the other situation because of its altitude and proximity to large mountains, but temperature-moisture conditions on the sunny exposures must be quite comparable to those of lower Piedmont outcrops.

There are no depressions on Rocky Face that are deep enough to form permanent pools, such as are often found on the eastern rocks. The shelf-like areas on many parts of the southern side of the mountain, however, produce a condition quite similar to the shallow depression of the eastern situation. Much of the bare rock surface of Rocky Face is gently sloping or nearly as level as the eastern outcrops.

The general vegetation of the wooded areas on and near Rocky Face shows many more resemblances to mountain plant life than to that of the lower Piedmont section under consideration. Late successional communities are therefore dissimilar. In the early stages of succession on the sunny exposure of Rocky Face, however, there is a striking resemblance to the pioneers on the rock outcrops in eastern North Carolina. The general successional pattern is the same, and a surprisingly large number of species are duplicated in the two places. Resemblances become less noticeable in the late herb stages, and there are few species duplicated on the mature mats.

Grimmia laevigata is the dominant pioneer on bare rock in both places. The Cladoniae that play an important part in the successional story on the eastern rocks, are not as common on the steeper surfaces of Rocky Face. *Diamorpha* is conspicuously present in both places, but of little importance in soil building in either. *Selaginella rupestris* follows *Grimmia* in both situations and is followed by early herbaceous plants.

Vegetational development in depressions is much alike in both places. Because of the greater slope and more erosion on Rocky Face, the depressions there are much more likely to collect thin layers of soil than on the eastern rocks. For this reason *Grimmia* is rarely found as a pioneer in the depressions of Rocky Face as it is in the eastern situation. On thin

layers of soil, in both places, a species of *Campylopus* is the dominant pioneer, *Campylopus flexuosus* on Rocky Face, and *C. introflexus* (Hedw.) Brid. on the eastern rocks. Cladoniae follow *Campylopus* and add greatly to the depth of the soil in both places. *Cladonia leporina, C. caroliniana,* and *C. tenuis* are the duplicated species. The typical form of *C. caroliniana,* according to Evans, may be confined largely to these granitic outcrops. *Polytrichum commune* follows the lichens on Rocky Face, while *P. ohioense* Ren. and Card. more commonly follows in the same order in the eastern area. *P. commune* is found on the eastern rocks but in damper situations than those where it grows on Rocky Face.

Plants of the herb stage that appear in both places are:

Crotonopsis elliptica	*Krigia virginica*
Diodia teres	*Linaria canadensis*
Hypericum gentianoides	*Talinum teretifolium*

Callicarpa americana is not reported from the eastern mats although it is common in the wooded areas of that section. This shrub, which becomes uncommon west of the lower Piedmont in North Carolina, is quite plentiful on the southern exposures of Rocky Face.

Forty Acre Rock, a granitic outcrop near the fall line in Lancaster County, South Carolina, is related to the eastern North Carolina outcrops by physiography and climate, and its vegetation is very similar (Huntley 1939). Growth forms, genera, and even species found on the south slope of Rocky Face are duplicated there.

Southward into the Gulf States are many more such outcrops which have been studied most intensively in Georgia (McVaugh 1943). Here are found many additional species, but the sequence of growth forms, and the major mat-forming genera are again those of the North Carolina Piedmont

This is as might be expected, for it becomes increasingly apparent that only a limited number of growth forms are adapted to become established on rock surfaces, that these forms succeed each other in a constant pattern, and that certain genera are apt to be involved in early stages in almost any situation of this sort. Differences from one locality to another are more apt to be in species than in genera unless macroclimate varies. But, within rather wide limits of climate, there is marked similarity of the vegetation on granitic outcrops, including growth forms, genera, species, and their successional pattern.

Thus it may be assumed that all vegetation is similar on outcrops in middle altitudes of the southern Appalachians and on shaded or north facing slopes in the upper Piedmont. Likewise, all southern exposures and unshaded flat expanses of rock in the Piedmont should have a closely similar mat-forming flora.

SUMMARY

1. The development of vegetation on exposed granitic slopes was studied on Rocky Face, a small mountain in the upper Piedmont of North Carolina, with a secondary objective of making comparisons with higher mountain and lower Piedmont situations.

2. Two principal lines of succession are recognizable, one on sunny southerly exposures and one on northern exposures. In both situations crustose and foliose lichens are present on bare rock surfaces but do not initiate succession.

3. On the sunny, dry, south slope, *Grimmia* is the pioneer whose compact mats are usually invaded only by *Selaginella rupestris*. In depressions or wherever thin layers of mineral soil accumulate, *Campylopus flexuosus* initiates succession and is followed by several species of *Cladonia*. The mat thus formed is invaded by *Polytrichum commune*. The Selaginella and Polytrichum mats are successionally equivalent and are both invaded by the same herbs (*Hypericum, Panicum, Danthonia,* and *Tradescantia*). *Pinus virginiana* and *Juniperus virginiana* soon appear after the herbs and are the dominants on the few old mats which have remained anchored. A shrub stage (*Callicarpa, Rhus, Chionanthus, Oxydendrum*) between herbs and trees appears only locally where substantial amounts of mineral soil have accumulated.

4. On the shady north slopes *Rhacomitrium heterostichum* var. *ramulosum* and *Hedwigia ciliata* are the pioneers whose mats are invaded and substantially thickened by several Cladoniae. Then *Polytrichum juniperinum* appears and builds a still thicker mat on which herbs (*Panicum* and *Danthonia* especially) grow densely but are soon shaded out by shrubs (*Robinia, Chionanthus, Rhus, Polycodium*). Late shrub stages are dominated by *Kalmia* and *Rhododendron*. A tree stage (not now present) would undoubtedly be made up, first, of pine and, if not destroyed, later of hardwoods.

5. The differences in species and successional pattern on the two slopes of Rocky Face are explainable in terms of temperature and moisture contrasts. Apparently conditions on the south slope approach those of outcrops in the lower Piedmont and those on the north slope are similar to those of higher mountain exposures.

6. The sequence of growth forms, genera, and even of several species involved in succession on south slopes parallel those of the succession on lower Piedmont outcrops. The same generalization applies to the north slope and higher mountain situations. The assumption may be made that, on granitic rock outcrops in middle altitudes of the southern Appalachians, the successional story is everywhere similar. The same generalization ap-

plies to outcrops with southern exposures and the flat unshaded outcrops throughout the Piedmont.

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SOME CYTOLOGICAL EFFECTS OF CORTISONE[1]

C. A. BERGER AND E. R. WITKUS

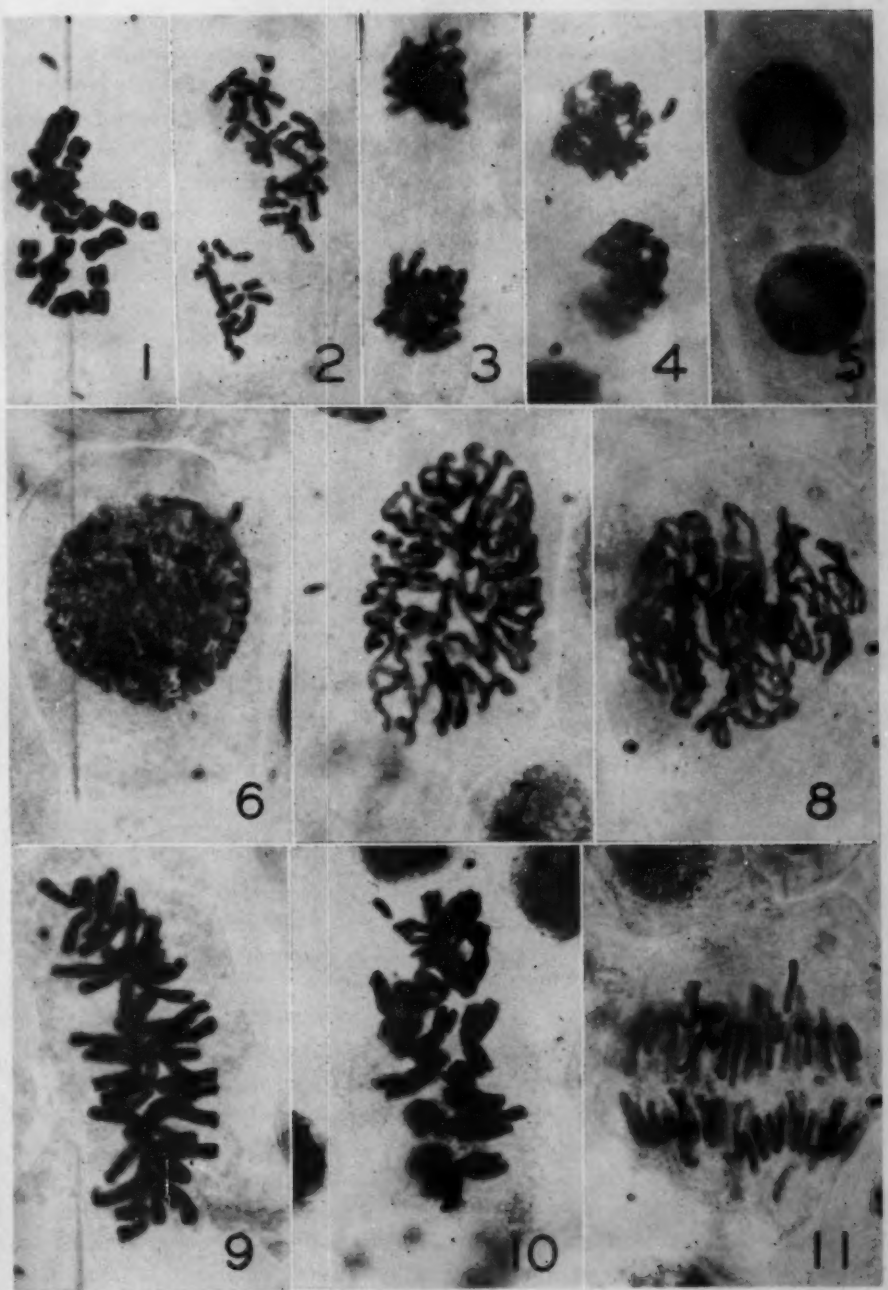
The fundamental differences in the cytological effects of colchicine and of naphthalene acetic acid on cell division have been described in previous papers (Berger & Witkus 1948; Witkus & Berger 1950). Similar studies with cortisone have yielded interesting cytological effects having points of similarity and of difference with each of the above mentioned substances.

Materials and methods. Cortisone acetate, MERCK, was obtained through the kindness of Dr. McMullen and Dr. Curtin of MERCK & CO. Root tips of *Allium cepa* were treated in three different ways. A saturated solution, containing 2 mg of crystalline cortisone acetate in 100 cc of tap water had no effect on dividing cells. The second solution was a supersaturated one and contained 200 mg of cortisone in 50 cc of water. In the third treatment cortisone crystals were dusted on the roots in a moist chamber. The last two methods produced striking effects. Apparently these effects are due to contact with the crystals. Roots showed no effects when growing through the saturated solution but when they reached the bottom of the container and came into contact with undissolved solid cortisone notable effects were obtained. These were not distributed uniformly throughout the root but were localized, presumably in regions which had been in actual contact with the crystals. Roots dusted with cortisone crystals and grown in moist filter paper in a moist chamber showed the most frequent and most pronounced effects although in this case also the effects were localized. The supersaturated solution contained an abundance of suspended, undissolved crystals. When roots were first placed in fresh solutions of this type, crystals adhered to the roots and pronounced effects were obtained. Roots placed in the same solution several hours later, when the crystals had settled to the bottom, did not show any effects until they had grown to the bottom of the container and had come into contact with the crystals.

Observations and results. Mitotic effects. Two classes of mitotic effects were observed, immediate effects which were noted at the end of six and twelve hour treatments, and recovery effects found in roots growing in tap water for twenty-four hours or more after treatment with cortisone.

The immediate effects were a retardation of the mitotic cycle, the chromosomes were more contracted than usual and resembled c-metaphase chromosomes (fig. 1), and the occurrence of abnormal anaphases. These were of

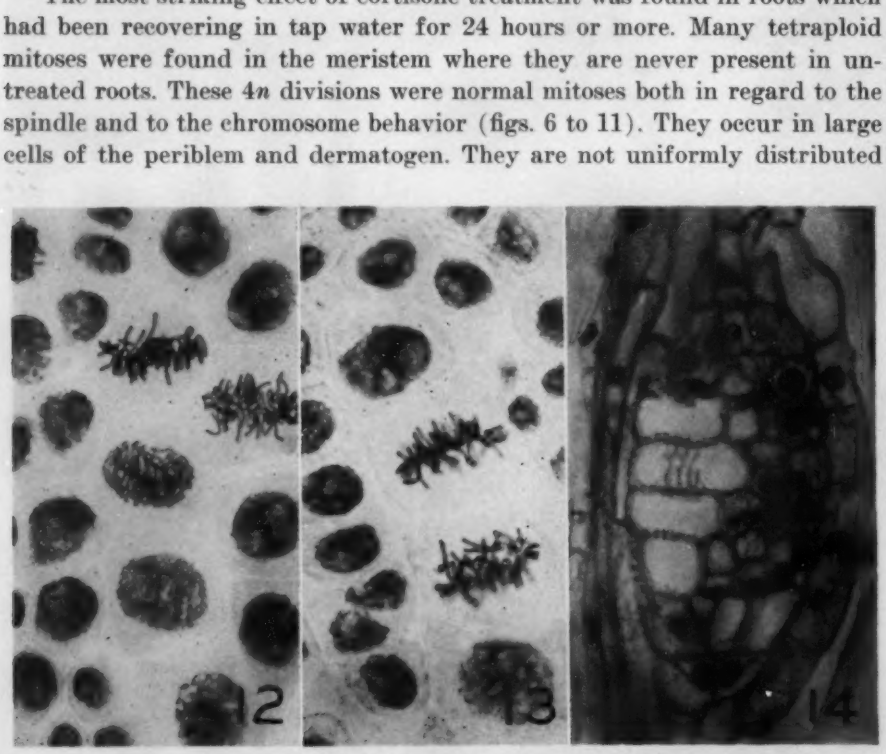
[1] This investigation was supported by a research grant from the National Cancer Institute, of the National Institutes of Health, Public Health Service.



FIGS. 1–11. Aceto-orcein smears of roots of *Allium cepa* treated with cortisone acetate. × 1000. FIGS. 1–5. Retarded diploid mitosis, abnormal anaphases and binucleate cell. FIGS. 6–11. Tetraploid cells in mitosis.

several types (figs. 2, 3 & 4); in some cases the chromosome movement was retarded but the division was completed, while in other cases no cell plate was formed and a binucleate cell resulted (fig. 5). These effects were noted in only some of the dividing cells of the meristem, the majority of diploid divisions were normal.

The most striking effect of cortisone treatment was found in roots which had been recovering in tap water for 24 hours or more. Many tetraploid mitoses were found in the meristem where they are never present in untreated roots. These $4n$ divisions were normal mitoses both in regard to the spindle and to the chromosome behavior (figs. 6 to 11). They occur in large cells of the periblem and dermatogen. They are not uniformly distributed



FIGS. 12–14. FIGS. 12 & 13. Localized groups of tetraploid cells × 400. FIG. 14. Secondary root primordium containing polyploid cells with walls thickened in the manner of scalariform vessels. × 300.

throughout the root tip but are localized in small groups or nests of large cells (figs. 12 & 13). In almost all cases the late prophase and metaphase chromosomes, 32 in number, were distinct from one another and not united in pairs by an undivided spindle attachment region. The latter condition was found only once (fig. 10). The mechanism by which this polyploid condition arises is still uncertain. Several possible methods were considered.

The theory that cortisone acts like colchicine was rejected because no true c-mitosis was observed. Cortisone delayed the formation of the spindle and in some cases caused spindle abnormalities but it did not inhibit spindle formation or destroy spindles.

The idea that cortisone acts like naphthalene acetic acid, and stimulates to division cells already polyploid, is more plausible but is also beset with serious difficulties. Naphthalene acetic acid induces cell division and reveals the polyploid nature of large cells in the region of elongation not in the meristem while the polyploid divisions found after cortisone treatment were very numerous in the meristem and very rare in the elongation region. Furthermore the polyploid divisions stimulated by naphthalene acetic acid show late prophase and metaphase chromosomes in pairs joined at undivided spindle attachment regions. This condition was found only once (fig. 10) in the cortisone treated material among the several hundred metaphases studied. Apparently, under the influence of cortisone, certain groups of cells increase in size and become tetraploid by a double chromosome reproduction in the resting nuclei.

Secondary root formation. In addition to the mitotic effects described above, some gross developmental changes were found. Roots treated with cortisone for long periods, up to nine days, showed a cessation of meristematic growth and elongation. Such roots formed numerous secondary root primordia, which are not normally formed in *Allium*. These secondary root primordia contained many tetraploid divisions. Some of these primordia gave rise to secondary roots; others failed to emerge from the primary root, their cells lost the meristematic character and, in some cases, the cell walls became differentiated with thickenings similar to those of scalariform vessels (fig. 17). A similar induced vascular differentiation was recently reported (Witkus & Berger 1950) in *Allium* after treatment with naphthalene acetic acid followed by colchicine.

SUMMARY

1. The cytological effects of cortisone acetate on *Allium* were studied.

2. Numerous tetraploid divisions were found in localized groups of cells in the meristem.

3. Many secondary root primordia were present containing numerous tetraploid divisions.

4. Tetraploidy arises, not by c-mitosis nor by a process similar to naphthalene acetic acid action, but by the localized induction of a double chromosome reproduction in the resting nuclei of certain groups of cells.

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TORREYA

BOOK REVIEWS

The Natural Philosophy of Plant Form. Agnes Arber. Cambridge at the University Press. 1950. 247 pp.

Mrs. Arber has approached the problems of plant form from the philosophical as well as from the botanical point of view. To her, morphology is not only the description and interpretation of external and internal structure of the plant throughout its life-cycle, but includes function as well; form and function are viewed as two aspects of the same unity in living organisms. Furthermore, she would free morphology from evolutionary preconceptions and concentrate on form in itself.

Three chapters are devoted to the history of Morphology. Emphasis is placed on the contributions of the Aristotelian School, of Albertus Magnus and Andrea Cesalpino, and upon progress from the time of Joachim Jung to Goethe and deCandolle. In this age when it is difficult to keep abreast of expanding techniques and the mass of new literature, it is well to be reminded that the history of botany should not be neglected; that the works of our pioneers are rich in originality and that re-examination of them in the light of modern knowledge may provide fruitful new leads for further investigations.

The body of the work consists of five chapters titled respectively: The Concept of the Organization Type; The Partial-shoot Theory of the Leaf; The Urge to Whole-shoot-hood in the Leaf; The Bearing of the Partial-shoot Thoery of the Leaf on other Morphological Problems; and Repetitive Branching and the Gestalt Type, with special Reference to Parallelism. In the organization type, an abstract concept as proposed by Goethe, a fundamental scheme of organization is evident, for example, as seen in the appendages of both vegetative and reproductive shoots. The gestalt type as set forth by Wilhelm Troll, a concept admittedly more difficult to grasp, brings together forms which are not uniform in organization. Two examples will suffice to illustrate what is meant. The embryo sac gestalt is an eight nucleate structure arising from one, two, or four megaspores; or the flower gestalt may be a single flower, a simple inflorescence, or a compound inflorescence. In other words, materials of more than one order may be built into structures which approximate each other in outward form and even in inward structure. An abundance of evidence is presented in support of the contention that the plant body is to be looked upon as shoot, and that, according to the partial-shoot theory leaves and roots can be treated as partial shoots. This theory, which has been more fully developed elsewhere in Mrs. Arber's published papers, is based on the occurrence of shoot characteristics in leaf and root. Repetitive branching in the shoot, as well as equivalence in form between leaf, pinna, and pinnule, is described as identity-in-parallel. Mrs. Arber is unrelenting in her search for unity within the plant body, a search which rewards the student with a profusion of beautiful line drawings and descriptions from her research and the literature of seed plants. In summation she states that ". . . we may call a shoot a microcosm of the whole plant: while a leaf; a leaflet; a leaf lobe; or even a hair to which a lobe may ultimately be reduced; is a microcosm of the whole shoot."

In a chapter devoted to the mechanism of plant morphology emphasis is placed upon differential growth, the effect of pressure on developing primordia, relative position and its bearing upon symmetry, and sex differences; unfortunately neither genetics nor the role of growth substances are considered.

The final chapter on the interpretation of plant morphology is puzzling. Undoubtedly many are in agreement with the concept that biological phenomena can not be entirely explained in material terms. Little seems to be gained, however, by recourse to Aristotelian philosophy.

In the reviewer's opinion, "The Natural Philosophy of Plant Form" will well repay careful study for its wealth of examples of plant form not considered in formal courses in morphology, for frequent excursions into the history of botany, for skillful culling and utilization of facts from opposing theories in the analysis of form, for unifying principles underlying plant form, and for glimpses into philosophy which are generally not found in botanical works.—M. A. JOHNSON, Department of Botany, Rutgers University, The State University of N. J.

An Introduction to the Anatomy of Seed Plants. By Ernest L. Stover. 288 pp. D. C. Heath and Company. 1951. $4.00.

The anatomy of seed plants is presented in sequence from the embryo and seedling stages to mature roots, stems, and leaves. In chapters 2, 3, 5 and 10, the material is presented, however briefly, from the developmental point of view. Chapters 3 and 6 through 9, give a fairly detailed coverage of ecological anatomy, particularly the chapters on the leaf. A list of general references is given at the end of each chapter. Also, a number of pertinent references are cited in the text which the student and teacher will find helpful. The book is well illustrated with photos and diagrams, the quality of the half-tones is unusually good.

Chapter 1 deals with embryos as five principal types. Under "Growth of the Embryo: Angiosperms," the author has followed Schnarf (1929) and Hanstein (1870) in assigning specific destinies to various regions of the meristem, designated as *dermatogen*, *plerome*, and *periblem*. That the introduction here of this terminology is questionable, follows from the authors rejection of these terms in describing shoot meristems. The general treatment is adequate although out-of-date.

Chapter 2 on seedlings includes a treatment of the primary root, hypocotyl, and cotyledons. Emphasis here is on crop plants which are somewhat atypical, but this chapter is well done, especially the section on the root.

Chapter 3 presents a discussion of secondary root growth, root modifications, and of root systems. Many examples, some ecological, are included, without emphasis on any particular group.

Chapter 4 is on cells and tissues. Logically, the author considers: the cell as a unit, growth of cells, cell maturation, and cell types. Representative works are cited and the general coverage is good. Exception might be taken to the statement (p. 53) that there is no evidence to show that vacuoles may not arise *de novo*, and to the use of the term "middle lamella" (p. 59, 62, 230, 232) interchangeably with intercellular substance. The author is to be commended on his awareness of the problem of using the term plant "tissue" and on the way in which this is handled (p. 59).

Chapter 5 considers buds, leaf origin and differentiation, and the general structure of the mature leaf. Chapters 6, 7, and 8 deal with mature leaf structure with particular emphasis on ecological variations. Chapter 8 has a section which summarizes the structure of leaves in relation to transpiration and wilting.

Chapter 9 gives a general treatment of the gross anatomy of stems and chapter 10 covers the origin and development of the tissues in stems. The presentation of the tunica-corpus concept (p. 164–166) could be improved upon, particularly with respect to the gymnosperms, but the overall coverage is good.

Chapter 11 is a very nice compilation and summary of the various methods of vegetative reproduction, based upon root, stem and leaf anatomy. There might be some difference of opinion as to whether parthenogenesis is asexual reproduction and, therefore, should be included here.

Chapters 12 and 13 deal with wood structure. Included in chapter 12 are the macroscopic features of wood and something of their economic importance, and in 13 the microscopic structure of wood useful in wood identification. The anatomy presented is sufficient to use the key in chapter 14 to common genera of woods in the U. S., although inclusion of pertinent topical references in the text would be most helpful. The key was not checked extensively, but worked quite well for a few test slides.

Nothing is included on flower, fruit, or seed. Two indices are provided. One is an index to structures and processes, the other to plants. This latter listing is more helpful in indicating coverage of families. The introduction contributes little and introduces a classification which is currently not acceptable to many botanists. Also, the characterization of Thallophytes and Bryophytes is quite inadequate. In chapter 1, objection is made to the use of the term "carpel" on p. 1, line 5.

The text is designed for a quarter or for one semester but, with included references, would be equally suitable for a year's course. This volume could also serve as a text in ecological anatomy since no other such satisfactory treatment is now available. Dr. Stover clearly exhibits a sound, thorough knowledge of vegetative plant anatomy and his textbook is a welcome addition to botanical literature.—J. E. GUNCKEL, Department of Botany, Rutgers University, New Brunswick, N. J.

FIELD TRIP REPORTS

March 25, 1951. Point Pleasant, N. J. Among the waterfowl observed were horned and pied-billed grebe; mallard, black, baldpate, shoveller, ring-necked, scaup, bufflehead and ruddy ducks, American and red-breasted mergansers; coot; killdeer; herring, ring-billed and black-backed gulls. Two of the ruddy ducks were approaching full breeding plumage, a condition not too often observed along our Jersey coast. Many species were not observed that were to be expected, but the delightful weather offset this. Attendance 4. Leader: David Fables.

April 8, Appalachian Trail, Blairstown, N. J. The hurricane of last Nov. 25 had made work for us. A total of 14 trees were found across the footway. These ranged from saplings to tree from which saw logs were cut. Nor was the wind a respecter of species. The blow-downs included dead chestnut, chestnut oak, scarlet oak, pignut hickory, white ash, red cedar, and pitch pine. Seventeen trees were down in the 4½ miles. Rue anemone and an early spring sedge were the only plants seen in flower. *Lycopodium lucidulum* was found. A beautiful specimen of the smooth green snake was seen well up on a shrub. The bird list was six of the most ordinary sort. Attendance 12. Leader: John A. Small.

April 15. Farmingdale and Allaire, N. J. The flowers in the Manasquan basin were very late. Erosion has cut the stand of Dutchman's breeches a great deal. We found wonderful stands of pyxie and arbutus in full bloom. Those who were there for the first time enjoyed viewing the old ruins and hearing of the Village. Attendance 9. Leader: V. L. Frazee.

April 21. Sandy Hook, N. J. The beach plum was not in bloom but shadbush more or less made up for it. Everyone admired the forest of large holly trees. They have become an extensive rookery of the black-crowned night heron—most unmusical birds. Woods, thickets, swamp, fresh marsh, open fields, sandy shores, and the bay afford a variety of sites that insures an interesting plant and bird population if the area is developed with even a minimum of planning along such lines. There will be room for bathing facilities of great extent along ocean and bay. Boating and other recreational activities can be provided in addition to the potentiality for interesting historical development. May the army soon vacate; it's an awfully exposed target! Attendance 15. Leader: J. J. Truncer.

April 22. Orange and Livingston, N. J. A great many plants in full bloom were located and identified. Four different violets, three blue and one white, were found. The May apple plants were unusually prolific. There were an unusual number of the red berries, very bright, lingering on the wintergreen. To anyone interested in a study of plant succession the Canoe Brook area is of particular interest. Part of the area we explored was once farm land under cultivation or pastured; part was always wooded with trees cut out over several generations. The former fields are now growing up in red cedar, hawthorne, blue berries and birch. These same plants creep in among old apple trees. Much of the open field is very wet. Mosses and mint are plentiful. The narrow streams harbor cresses, forget-me-not, jewel weed, a few pools of algae. With change of elevation one moves from the flood plain trees to the trees of the drier slopes. A great part of the forest is predominantly oak with dogwood and tulip trees conspicuous. Attendance 5. Leader: Miriam Studley.

April 28. Lakehurst, N. J. Owing to the illness of Mr. Fables, Mrs. Camp and Mr. Frazee conducted this trip. We found a beautiful stand of *Helonias bullata* in a new location for the Torrey Club; more than fifty specimens were in bloom. The stand of *Viola Rafinesquii* at Colliers Mill did not have a single flower. Whether this is permanent or only for this year remains to be seen. Attendance 4. Leader: Mrs. Percy Camp.

April 28. Bear Mountain, Beechy Bottom Section, N. Y. High lights of the day's trip were not botanical. We found recent excavation work of the pileated woodpecker in a partly dead red oak. Usually this bird chooses softer wood. The other bird of note was a white-winged crossbill, male, singing. Hepatics were represented by an abundance of only a few species: *Chiloscyphus rivularis* on stones in brooks; *Scapania memorosa* in moist places; *Frullania eboracensis* on white oak and elm. Mosses were abundant. Christmas, ebony, spleenwort, polypody, marginal shield, sensitive, lady, rattlesnake and cut-leaved grape ferns were observed. Among the lichens were *Cladonia cristatella, C. chlorophaea, C. coniocraea, C. rangiferina* and *Physcia endoricea.* Flowering herbaceous plants were numerous. Trees of note were reforested European larch now in their second or third generation, red pine and a little Norway spruce. Shad-bush was in bloom. The terrain is rather dry and rocky; the rock ledges micaceous (muscovite mica) from weathered granite. Local small bogs and swales, and a long abandoned beaver pond site were noted. Attendance 3. Leader: Lee A. Ellison.

April 28–29. Media, Pa. The spring countryside of this lovely Pennsylvania section offered a splendid trip. We saw what most of us agreed were the grandest stands of springbeauty and of "Brandywine bluebell" (*Mertensia virginica*) that any of us had ever seen anywhere. Cutleaf toothwort, blue-cohosh, and many kinds of violets were also in great abundance. Attendance 15. Leaders: Harold N. Moldenke, Morris Berd.

April 29. Milford, N. J. Survey of some two and one-half miles along the river road north of the town of Milford was made. There had been sufficient rain recently to cause water to spill attractively over the rocks at the somewhat hidden waterfall. A dozen species were added to the list of the flora of this region now being compiled by David Fables. Among these additions were: *Hybanthus concolor* (a sizable stand located), *Antennaria Parlinii, Lithospermum arvense, Medicago lupulina, Veronica persica, Viola Rafinesquii.* Attendance 4. Leader for David Fables: Louis E. Hand.

May 6, West Park, N. Y. The prominent features of the trip to Slabsides were a talk by Julian Burroughs and the finding of great masses of long-spurred violet, two kinds of yellow violet, sweet white violet, and three blue violets, large quantities of crinkleroot, wood betony, columbine, bladdernut, smooth rock-cress, showy orchis in full bloom, and a large stand of golden saxifrage. Attendance 18. Leader, Dr. Harold N. Moldenke.

May 12. Arboretum of the Barnes Foundation, Merion, Pa. The outstanding feature of this extremely interesting trip with the Botanical Society of Pennsylvania was a magnificent specimen of the dove tree just at the height of its profuse and spectacular blooming. A new large rock garden has been built recently and includes many unusual plants such as a dwarf Cryptomeria. Attendance 40. Leaders: Mrs. Barnes and Dr. Steckbeck.

May 13. Kissena Park, Queens, N. Y. We first visited the fast disappearing swamp opposite the park where a number of the common wild flowers and weeds were observed. The remainder of the time was spent in the park identifying the many fine specimens of cultivated flowering trees and shrubs. Attendance 8. Leader: Emanuel D. Rudolph.

May 27. Dover—Mt. Hope, N. J. (Dunnfield Creek Section). This trip was quite successful botanically but heavy continuous rain starting at noon caused us to end the trip earlier than planned. *Ledum groenlandicum*—the only known station in New Jersey—was in fine flower. Other plants in the bog included *Larix laricina, Calla palustris, Vaccinium oxycoccus.* In the woods the lady slipper was quite abundant and one fine albino plant was much admired and photographed. The swamps at Mt. Hope contained many plants of *Calla palustris* in full flower. Attendance 9. Leader: Louis Hand.

June 3. Lakewood, N. J. We visited the lady slipper woods near Van Hiseville and and found the majority of the blooms past their prime but there were however, several very good specimens. Following lunch at the leader's home we went to the always interesting Island Beach. Attendance 9. Leader: Mrs. Percy Camp.

June 10. Voorhees State Park, Highbridge, N. J. One purpose of this trip was to extend the list of plants to be found in the Park. Twenty-two species of seed plants were added, largely common plants of the season. Several species of lichens were observed. Attendance 3. Leader: Louis E. Hand.

June 17. Lebanon State Forest, N. J. The climbing fern was seen along the Rancocas Creek at New Lisbon. A lowland area just within the State Forest produced characteristic plants such as sweet pepperbush, high-bush blueberry, dangleberry, sheep laurel, swamp azalea, turkeybeard, pitcher plant, pyxie, and sundew. A dry area was visited for Hudsonia, sand myrtle, pine barrens chickweed, dwarf chestnut oak, low-bush blueberries, and spurge, as well as the expected oaks and pines. After viewing several plots in the prescribed-burned area, we listened to an explanation of procedure and results by Dr. Little. A study of the effect upon ground plants and shrubs was described by Dr. Buell. The group then visited a cedar swamp. Curley-grass fern, Arethusa, and Helonias were the most unusual plants seen. Bladderwort and other insectivorus plants were abundant. Attendance 30. Leaders: Murray Buell, Silas Little, and John Small.

FLORAL EPONYMS

Cinchona (The Countess of Chinchon, Dona Francisca Henriquez de Rivera) is a genus of perhaps sixty, mostly Andean, trees of the family Rubiaceae. *C. officinalis*, long thought to be the best source of quinine has been replaced by Javanese hybrids.

In 1663, Sebastiano Babo wrote that the wife of the Viceroy, the Count of Chinchon, had a severe attack of tertian fever. She was quickly cured by the bark of a native Peruvian tree. The bark was for that reason called the "Countess's Powder." This story was unquestioned until recently. It was also believed that the Countess of Chinchon introduced the remedy into Europe. In 1930, Miss I. A. Wright, on behalf of Sir Henry Wellcome, discovered the official diary of the Count of Chinchon for the period he served as Viceroy of Peru. This diary gives detailed accounts of the illnesses, not only of his family, but of all prominent people in Lima at the time. There is no evidence that the Countess had tertian fever. Furthermore, the Countess did not return to Spain and distribute the remedy on her lord's estates in the valley of the Tagus. She died on her way home and was buried at Carthagena, Columbia, January 14, 1641. For those who are interested in the unbelievable number of errors in the history of quinine, the account of A. W. Haggis (Bull. Hist. Med. 10: 417 and 568, 1941) is revealing.—M. PIERCE RUCKER, M.D., and Virginia Medical Monthly.

Alstroemeria (Alstroemer, Claude. 1736–1794.) is a large genus of South American amaryllidaceus plants having fibrous roots, leafy stems, and umbels of variously colored flowers.

Baron Claude Alstroemer was a friend of Linneaus. On a trip to Spain he described a plant, the Lily of the Incas, which Linnaeus named for him. Alstroemer was a member of the botanical society of Florence and of the Royal Academy of Stockholm, of which he was at one time the president.—M. PIERCE RUCKER, M.D., and Virginia Medical Monthly.

Zinnia (Zinn, Johann Gottfried. 1727–1759.) is a genus of about 15 species (three of them recognized in Bailey's Manual of Cultivated Plants) of annual or perennial herbs chiefly found in Mexico, Colorado, Texas, and Chile.

Johann Zinn was born at Schwabach. He graduated M.D. at Göttingen in 1749 and pursued his studies in anatomy and botany at Berlin. He was Professor of Medicine in Göttingen where he died in 1759. He is remembered in medicine for his work on the anatomy of the human eye and by botanists for the Zinnias.—M. PIERCE RUCKER, M.D., and Virginia Medical Monthly.

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BIOLOGICAL ABSTRACTS

University of Pennsylvania
Philadelphia, Pa.

BULLETIN OF THE TORREY BOTANICAL CLUB

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NOTES ON VAUCHERIACEAE, WITH PARTICULAR REFERENCE TO WESTERN NEW YORK[1, 2]

JOHN L. BLUM

In the study of Vaucheria species, both as dried material in various herbaria, and as preserved or dried specimens in the writer's own collections, mostly from Western New York, the following new or otherwise interesting forms have been found. All the specimens cited are deposited in the Herbarium of the Chicago Natural History Museum unless otherwise indicated.

VAUCHERIA ARECHAVALETAE Magn. & Wille, in Wille, 1884. This species was first collected near Montevideo, Uruguay, in 1875, by Arechavaleta, and sent via Professor Pringsheim to Magnus and Wille in Berlin. Vaucheria material, fruiting abundantly, which appears to represent this species, was collected by the writer on wet soil bordering Otter Creek, ca. ½ mi. south of Eagle Harbor Station, Orleans Co., N. Y., on May 2, 1950. Apparently the species was not collected in Uruguay or elsewhere between 1875 and 1950. Subsequent visits to Otter Creek have yielded no further fruiting material.

There are certain apparent differences between the New York material and that from Uruguay, which are particularily evident when Wille's drawings are studied and compared with the New York material. Tracings of his figures 60–62, Plate 2 (Wille 1884) are reproduced herewith (figs. 1–3), for comparison with, and to the scale of, drawings of the New York material (figs. 4–6).

Figure 1 shows a fruiting branch which has proliferated to form an additional oogonium and antheridium, and figure 3 shows a fruiting branch with two extra branchlets from which the oospores or antheridia have already become detached. Such variability is commonplace in *Vaucheria* species generally. Of 80–100 fruiting branches of the New York material studied, however, no such branching has been observed, and all fruiting branches without exception bear a single oogonium and a single antheridium. In other respects the New York material is equally uniform. The dimensions of the oogonia, for example, vary within narrow limits which are given below. These oogonial dimensions are considerably smaller than those given by Magnus and Wille; and the New York material is further distinguished

[1] The writer expresses his indebtedness to the New York Botanical Garden and the Chicago Natural History Museum for the loan of specimens, and to Dr. C. E. Taft, who has generously opened to the author his extensive files on Vaucheria species.

[2] Illustrations published with the assistance of the Lucien M. Underwood Memorial Fund.

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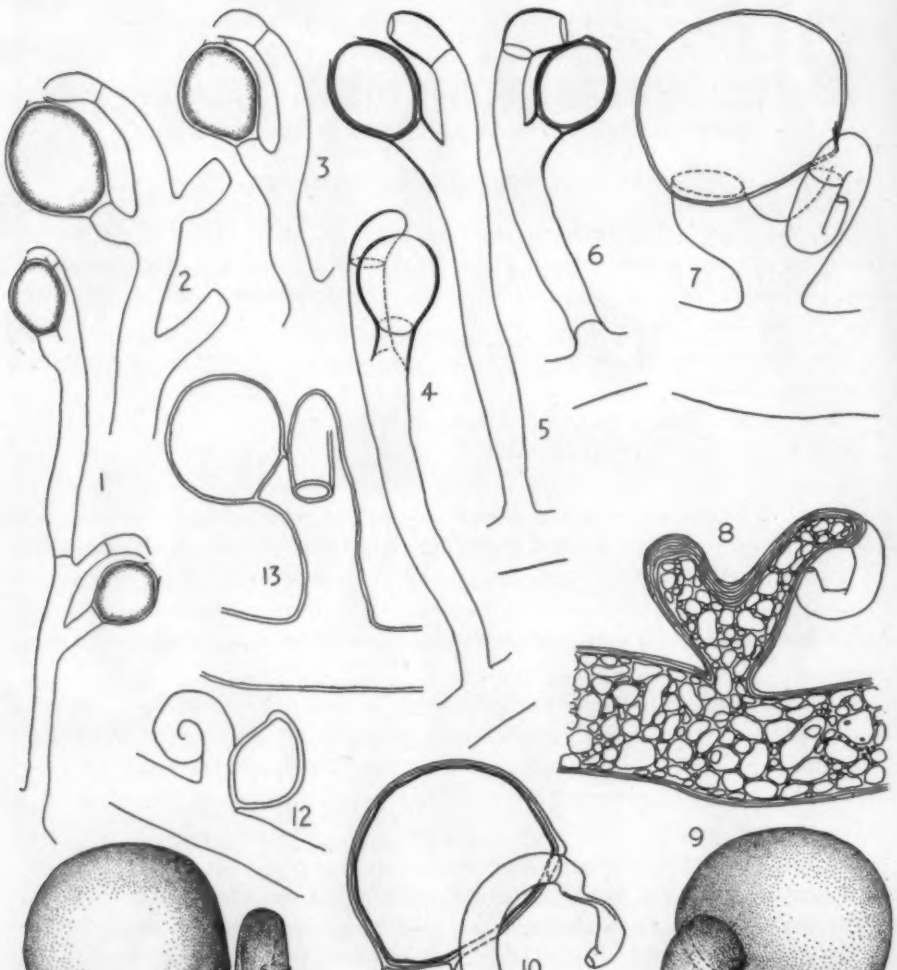

FIGS. 1–13. FIG. 1–3. Pantograph tracings of original figures of *Vaucheria Arechavaletae*, after Wille. FIGS. 4–6. Western New York material of *V. Arechavaletae*. FIGS. 7–11. *V. brevicaulis* Blum sp. nov. FIGS. 7, 9–11. Fruiting branches with oogonia. FIG. 8. Fruiting branch after detachment of oospore. FIG. 12. Pantograph tracing of Wood's Figure 3, Plate 20, one of the original figures of *V. polymorpha*, with shading omitted, after Wood. FIG. 13. Pantograph tracing of Arechavaleta's Figure 3, Plate 6, the original drawing of *V. macrocarpa*, with shading omitted, after Arechavaleta.

by much thickened cell walls of (1) the mature antheridium, (2) the mature oogonium, and (3) the mature oogonial branch or pedicel. The description and figures in Wille's paper give no indication of this very noticeable thickening, which constitutes the principal objection to identifying the New York material with *V. Arechavaletae*.

The evidence on the whole seems, however, to favor such an identification, as other details and dimensions of the New York material are in close accord with the published description.

Since the description of *V. Arechavaletae*, three other species of questionable affinity to it, and apparently of equal rarity, have been described, namely, *V. subarechavaletae* Borge from Patagonia, *V. prolifera* Dangeard from France, and *V. Jaoi* Ley, emend. Jao & Ley (including *V. Jaoi* f. *minor* Jao and Ley) from China. *V. prolifera* and *V. Jaoi* are characterized by sessile oogonia and short antheridia; *V. subarechavaletae* is a species of larger size characterized by somewhat compressed oogonia and by long antheridia on unusually long stalks.

The original description of *V. Arechavaletae* was based on its similarity to *V. De Baryana* Woronin, since its principal deviation from that species lies in its cylindric antheridia, which have but a single opening in contrast to the deltoid or capitate antheridia of *V. De Baryana*, which have one to four lateral pores. This difference is, however, probably a basic one as Jao and Ley (1947) have pointed out, and should warrant exclusion of *V. Arechavaletae* and species with essentially similar antheridia from the Section Anomalae.

This opinion seems to be borne out by the aforementioned wall thickenings on oogonia, antheridia, and oogonial pedicel of the New York material determined as *V. Arechavaletae*. The writer has examined material of *V. De Baryana* in an unsuccessful effort to find similar thickenings in that species. If the presence of such thickenings be taken as evidence against close relationship of *V. Arechavaletae* with *V. De Baryana*, however, it applies with equal force against its close relationship with *V. subarechavaletae*, *V. prolifera*, and *V. Jaoi*, all of which species, to judge from the descriptions and obviously careful drawings of each author, completely lack such thickenings. These latter species are distinctive in character and it must be admitted that in hasty examination the New York material strongly resembles *V. De Baryana* in size and general appearance much more so than it resembles the other species in question.

In view of the brevity of the published description of *V. Arechavaletae*, the following description of the New York material supposedly referable to this species, is presented:

Vegetative filaments seldom branched, 23–38 μ in diameter; oogonia and antheridia borne on lateral fruiting branches 160–260 μ in total length;

antheridia cylindric and short, opening by a single large terminal pore; antheridia terminal on the fruiting branch, and bent slightly toward the apex of the oogonium, 16–23 × 23–35 μ; oogonia ovoid, sometimes with truncated base, opening by a large apical pore; oogonium borne on a short pedicel which arises laterally on the fruiting branch below the antheridium; oogonial apex at the same level as, or slightly below, that of the antheridium; oospore filling the oogonium and having the same shape, its membrane smooth; walls of the mature oogonium, antheridium, and oogonial pedicel, are markedly thickened.

The species related to V. Arechavaletae. Jao and Ley (1947) have proposed the section Pseudoanomalae to accomodate *V. Arechavaletae, V. subarechavaletae,* and *V. Jaoi,* all of which are characterized by cylindric or slightly curved antheridia with a single terminal pore. *V. prolifera* was described by Dangeard (1939) and assigned to the Globiferae because of its saccate antheridia, sessile oogonia, and the apparent lack of special fruiting branches (although the latter point is not specifically mentioned by Dangeard). The saccate type of antheridium is not, however, basically different from the antheridium of the Pseudoanomalae, particularily from that of *V. Arechavaletae.* There are, moreover, certain striking similarities between *V. prolifera* and *V. Jaoi,* which bear consideration. Both are of small size, both have sessile oogonia and cylindric, saccate or slightly curved antheridia terminal on the fruiting branch, with the antheridium more or less directed toward the oogonium, and both exhibit the same unusual manner of growth. The following excerpts from the respective authors will point up this similarity:

(*V. prolifera*) "Les organes sexués présentent la particularité de se développer exclusivement à l'extrémité des branches ou ramifications du thalle d'ordre quelconque. . . . Après la formation des organes sexuels le filament n'interrompt pas sa croissance, mais il la poursuit généralement en ligne droite jusqu'à ce que, à une certaine distance il produise de nouveau et de la même façon, une anthéridie et un oogone; les anthéridies deviennent donc successivement latérales après avoir été momentanément terminales. . . . On peut compter parfois qu'il s'est formé trois séries de couples oogone-anthéridie sur un même filament rectiligne." (Dangeard 1939).

(*V. Jaoi*) "The sex organs are mostly borne on the fruiting branches, but may sometimes develop on the end part of the main filaments. . . . In ordinary cases only a single set of the sex organs arises on each fruiting branch. . . . In unusual cases, the end of the fruiting branches may bud at a short distance below or near the base of the antheridium to develop a short branchlet, on which a new set of sex organs of second order may arise later. . . . Occasionally, this kind of budding may take place twice

resulting in a complex fruiting branch bearing three normal sets of sex organs. . . ." (Jao and Ley 1947).

Similar continued growth of the fruiting branches is found in species of Corniculatae such as *V. geminata* (Vauch.) DC. and *V. hamata* (Vauch.) DC. but is not found in other species of the genus which lack special fruiting branches.

The lack of special fruiting branches in *V. prolifera,* if true, is indeed a point of distinction between that species and other species such as *V. Arechavaletae.* However, as soon as the fruiting branches become indeterminate in length, the presence of *special* fruiting branches becomes uncertain. Thus, the considerable length of fruiting branches figured for *V. Jaoi* by Jao and Ley, raises some question as to whether or not *V. Jaoi* is essentially different from *V. prolifera* in this respect. There can be no doubt, in view of the other characters of each, that they are entirely distinct entities, but consideration of their similarities shows the inadvisability of relegating them to entirely different sections of the genus.

Vaucheria brevicaulis Blum, sp. nov. figs. 7–11. Filis 42–78μ latis; ramis fructiferis admodum brevis, oogonium singulum et antheridium singulum ferentes; ramis fructiferis singulis, carptim distributis, nonumquam geminatis, basis adjunctis; antherdiis in ramis fructiferis acrogenis, recurvis, circinatis; oogoniis subreniformis, stipitis in segmentis corpulentis insidentibus, his segmentis tam longis vel longioribus quam stipito; segmento oogonii angulum ca 45° contra segmentum alterum graciliorum effecente; axe oogonii curvato aliquid adversus planus antheridii; oospora eandem formam praebente quam oogonium, oogoniumque complente, cum membrana laeva, crassa, duorum stratorum, 100–120 × 122–143 μ; post sejunctionem oosporae, membranae ramorum fructiferum crassae usque ad 11 μ latae sunt.

Filaments 42–78 μ in diameter; oogonia and antheridia borne on a very short fruiting branch, a single oogonium and a single antheridium on each fruiting branch; fruiting branches isolated from each other, occasionally in pairs, their bases adjoining; antheridia terminal on the fruiting branch, circinate; oogonia subreniform, on stout pedicels as long as or longer than the fruiting branch; pedicels of the oogonia forming an angle of ca. 45° with the more slender continuation of the fruiting branch which bears the antheridium, the axis of the oogonium curved somewhat toward the plane of the antheridium; oospore filling the oogonium, having the same shape as the oogonium, with a smooth, thick, two-layered wall, 100–120 × 122–143 μ; after detachment of the oospore, the walls of the fruiting branch become heavily indurated, up to 11 μ in thickness.

TYPE: Growing in shallow water at the far west end of a pond 4 mi. east of Albion, Orleans County, N. Y., on May 2 and May 25, 1950 (J. Blum 469 and 486).

V. brevicaulis is most closely related to *V. terrestris* (Vauch.) DC. and *V. hamata* (Vauch.) DC., and should be assigned to the Racemosae (Sect. Corniculatae). A study of American and European herbarium material of

species in this group has revealed no comparable material, and the writer concludes that this material represents a hitherto undiscovered and undescribed species.

The principal distinction between *V. brevicaulis* and related species lies in the extreme shortness of its fruiting branch. *V. hamata* and *V. terrestris* have fruiting branches which average 80–250 μ from base to the point of attachment of the oogonial branch. *V. brevicaulis* measures 0–45 μ for this dimension.

The genus Vaucheria is not without descriptions of forms allied to *V. hamata* which raise doubts, because of their incomplete or vague character, as to the nature of the plant intended. Notable among these are *V. macrocarpa* Arechavaleta and *V. polymorpha* Wood. *V. macrocarpa* is a species of questionable validity which Arechavaleta described (1883) from Independencia, Uruguay. Although both the written description and the drawing stand as inaccurate and incomplete descriptions of *V. hamata* or *V. terrestris*, and are, of course, antedated by the descriptions of DeCandolle and others, they do strongly suggest these two widespread species. The single illustration of *V. macrocarpa* (figure 13, a tracing of the original figure) is unusual in that it shows a fruiting branch proportionately shorter than in typical material of *V. terrestris* or *V. hamata*. No clear distinction is made, however, if indeed any was intended, between *V. macrocarpa* and other better-known species, so that one is obliged to disregard Arechavaleta's description. *V. polymorpha* Wood (1872) was described from material collected by Ravenel near Houston, Texas. This species was based upon the unusual fruiting branches, especially branches which bore an antheridium but no oogonium. At least one of Wood's drawings would be accurate, in general, for American material of *V. terrestris* or *V. hamata*. Another drawing, of an extremely short fruiting branch, suggests *V. brevicaulis*. Figure 12 is a tracing of this drawing. As is the case with *V. macrocarpa* Arechavaleta, the description is adequate neither to identify *V. polymorpha* with other species which are better known, nor to render such identification out of the question. It seems unlikely, in view of the variability in *V. terrestris* and *V. hamata*, and the occasional occurrence within these species of forms approaching those described and illustrated by Wood, that it represents a unique species, and in view of collections made and knowledge gained since Wood's time, it seems preferable to disregard it.

Specimens examined; *Vaucheria macrocarpa*, Uruguay (Herb. N. Y. Bot. Gard.), No. 1023 of Wittrock and Nordstedt's *Algae exsiccatae*, consists of *V. geminata* (Vauch.) DC. The writer has been unable to find specimens of *V. polymorpha* Wood.

Miscellaneous notes on other species. *V. pseudo-geminata* Dangeard 1939, has been found in a collection of soil algae from Florida (*Francis Drouet, Grace Madsen, & Dorothy Crowson*, Plants of Wakulla Co., Fla.

10802, St. Mark's River, Newport, 1949). This material agrees perfectly with Dangeard's description, except for having larger oogonia (French material: 30–40 × 40–65 μ, Florida material: 47–57 × 60–71 μ). This appears to be the first reported collection since the species was described, and to be the first recorded from the Western hemisphere.

V. De Baryana Woronin. Specimens examined—Flora of Nebraska 13882 (in part), Fremont, Dodge Co., 1943; id. 16538 (in part), Benkelman, Dundy Co., 1944; id. 22919, Beemer, Cuming Co., 1947, all terrestrial algae collected by W. Kiener. These appear to be the first records of this species for the United States outside of California (Hoppaugh 1930; Prescott 1938).

The following species, among the less common ones in the family, have been identified in the writer's New York collections; the numbers listed refer to these collections:

V. aversa Hassall, 504 (Cattaraugus Co.), 566 (Hamilton Co.).

V. pachyderma Walz, 483 (Niagara Co.).

V. polysperma (Hassall) Migula, 391 (Genesee Co.).

V. uncinata Kützing, 549 (Erie Co.).

Vaucheriopsis arryncha (Heidinger) Heering (= *Vaucheria arryncha* Heidinger), 331 (Erie Co.), 566 (Hamilton Co.).

Dichotomosiphon tuberosus Ernst, 311 (on wet soil, bank of a temporary stream, Erie Co.).

SUMMARY

1. A New York collection of *Vaucheria Arechavaletae* Magn. & Wille, a species not otherwise collected since its discovery in 1875, is described.

2. Evidence is presented to show that *V. prolifera* Dangeard, placed by its author in the Globiferae, and *V. Jaoi* Ley placed by Jao and Ley in the Pseudoanomalae, are closely related species which should be assigned to a common section of the genus.

3. *V. brevicaulis* is described as a new species from Western New York.

4. New collection records of several of the rarer species of Vaucheriaceae are given, including the first record from the Western hemisphere of *Vaucheria pseudo-geminata* Dangeard.

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BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, NO. 6, PP. 449–457. NOVEMBER, 1951

CORDAITES AFFINIS: A NEW SPECIES OF CORDAITEAN LEAF FROM AMERICAN COAL FIELDS[1]

FREDDA D. REED AND MARY TONNESON SANDOE

The pieces of calcareous rock which yielded the leaf fragments for the following description, were generously supplied by Dr. L. R. Wilson of the University of Massachusetts. The material was collected from a strip mine in the vicinity of What Cheer, Iowa, a locality ascribed to the lower portion of the Des Moines series of Pennsylvanian age.

Well preserved Cordaitean leaves were found distributed throughout the pieces of rock. The cleavage planes coincided with the planes along which the leaves were stratified, layer upon layer, so that when the rock was broken into small slabs, one or the other epidermis of a leaf was exposed at the surface. It was from these small slabs that the epidermal pattern was determined. The pieces were washed to rid them of any extraneous material, were dried, then coated with cedar oil which provides a good reflecting surface and makes possible cellular examination with reflected light.

The internal structure of the leaf was revealed in celloidin peels and in thin sections. In the preparation of the latter, the slabs were oriented to provide views of the leaf in various planes. Some of the thin sections were placed in safranin for 24 hours, then differentiated in 95% alcohol: after this process the thickened walls of the cells were found to have retained the stain.

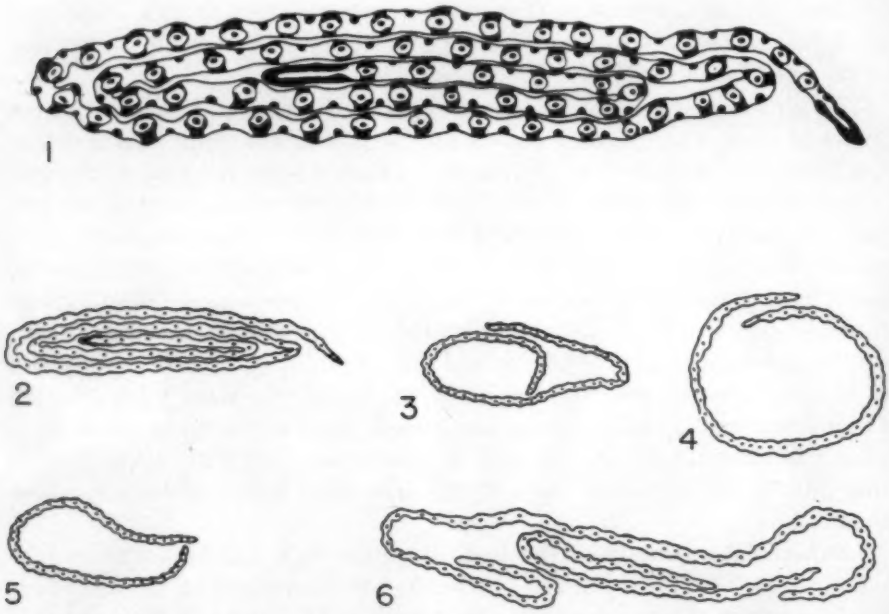
Superficial structure of the leaf. Since the rock had been broken into small pieces (about three inches square) before the authors received it, there is no hint from this material as to the length of the leaves. The longest segment found was only about eight centimeters, but this is regarded as a mere fragment of the total length. The leaves as exposed on the surface appeared flat and never exceeded 1.7 cm. in width. However, when the rock was sectioned many of the leaves were discovered to be inrolled, sometimes doubled on themselves several times (figs. 1, 3, 4, 5, 6). Often they were preserved from margin to margin, the widest of these was 4.5 cm. (fig. 1).

The surface was relatively smooth with fine, closely-set, parallel (occasionally dichotomizing) ribs running longitudinally (figs. 7, 8). The primary ribs, the number of which varied from 40–60, are strong bands of hypodermal tissue accompanying the vascular elements. Being composed of thick-walled fibrous cells they were resistant to crushing which in the majority of the leaves flattened the intervening or inter-rib areas. It is these bulging

[1] Illustrations published with the assistance of the Lucien M. Underwood Memorial Fund.

hypodermal bands that are responsible for the undulating appearance of the surface of the leaf.

There is a certain resemblance between the superficial appearance of the upper and lower epidermis (fig. 7, 8) but upon closer inspection some salient features differentiate them. Between the primary ribs of the upper epidermis, and parallel with them, were two or more delicate striations or secondary ribs (fig. 7), while on the lower surface a single slender but distinct secondary rib was found alternating with the primary ribs (fig. 8).

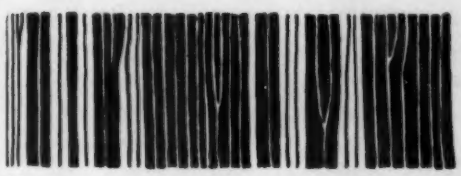


FIGS. 1–6. Transverse sections of *Cordaites affinis*. FIG. 1. Diagram of the widest leaf found, showing the undulating surface, the vascular strands and accompanying fibrous 'ribs.' TR-1. FIGS. 2–6. Sections of different leaves (drawn to the same scale) demonstrating differences in width, number of vascular strands, and the degree of in-rolling. TR-21, TR-22.

The stomata are confined to the inter-rib portion of the lower surface (fig. 8.).

The epidermal cells of the upper surface were essentially uniform in their general appearance (fig. 10). They are longitudinally elongated, average 20 micra in width by 60 micra in length, and possess relatively thick walls. Aside from the darker color of the cells in the rib region there was no apparent difference between them and those of the inter-rib region.

The cells of the lower epidermis in the rib region were scarcely distinguishable in form or dimensions from those of the upper epidermis in the corresponding position (fig. 11). However, in the inter-rib areas are slightly



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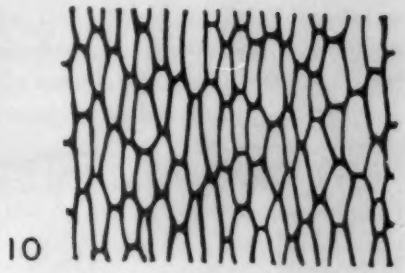

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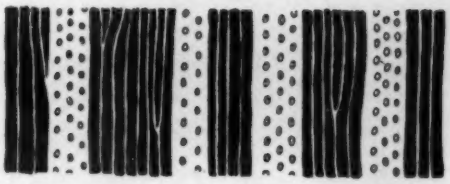

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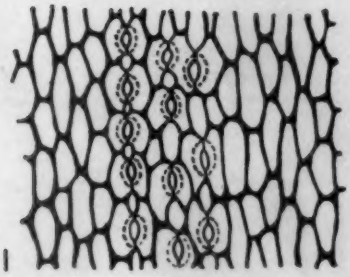

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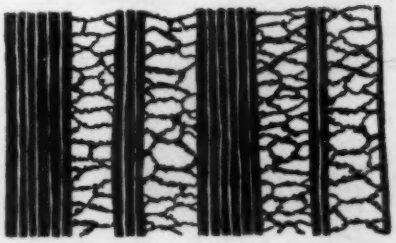

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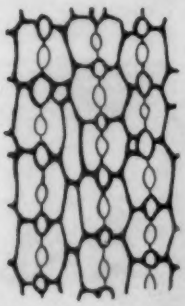

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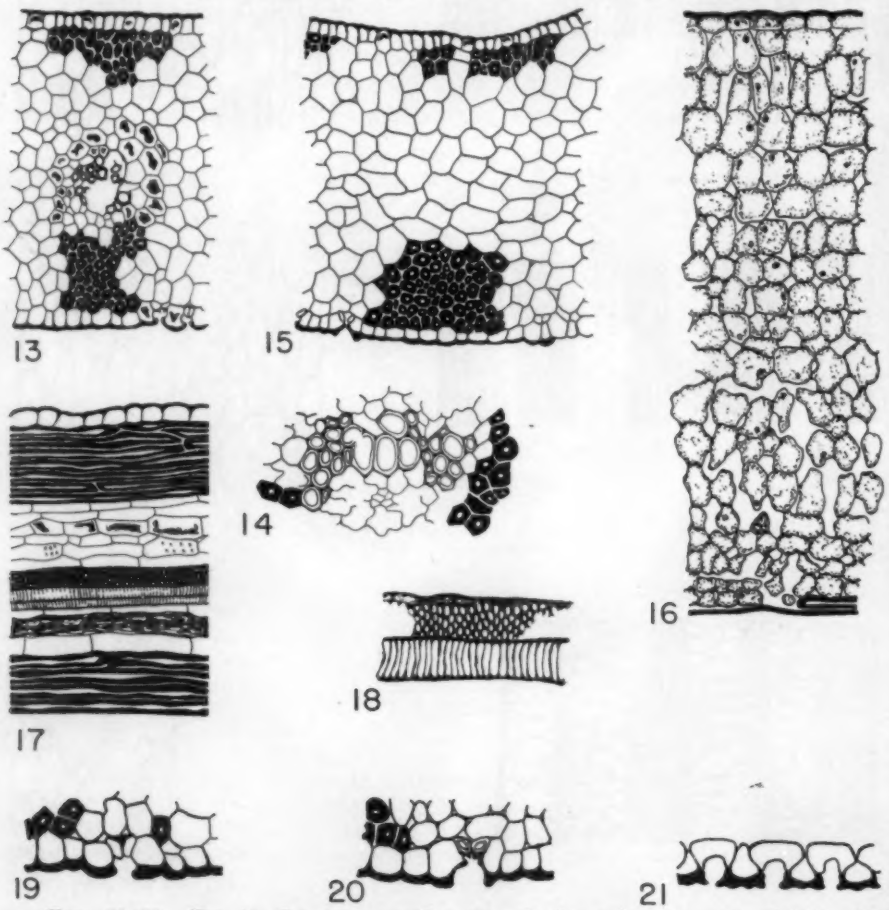
FIGS. 7–12. Camera lucida drawings of surface views of *C. affinis* made from the slabs of rocks which were subsequently sectioned in order to provide transverse and longitudinal sections of the leaf. FIG. 7. Diagram of portion of the upper surface showing the relation of the primary and secondary ribs (the shaded areas) and the intervening furrows. FIG. 8. Diagram of portion of the lower surface, showing frequency and distribution of the stomata in the inter-rib areas. FIG. 9. Diagram of tangential section through the ribs and spongy parenchyma, the latter in chains of anastomosing strands. FIG. 10. Cellular detail from the upper epidermis. FIGS. 11 and 12. Cellular details from the lower epidermis; the stomata, in three longitudinal rows, surrounded by lateral and terminal subsidiary cells; the sunken guard cells are not visible but are indicated by dotted lines in figure 11.

depressed furrows where there are longitudinal rows of specialized cells composing the stomatal apparatus (fig. 11). There are from two to five, usually three, longitudinal rows of stomata within each furrow (figs. 8, 11). Each stomatal apparatus consists of four subsidiary cells surrounding two

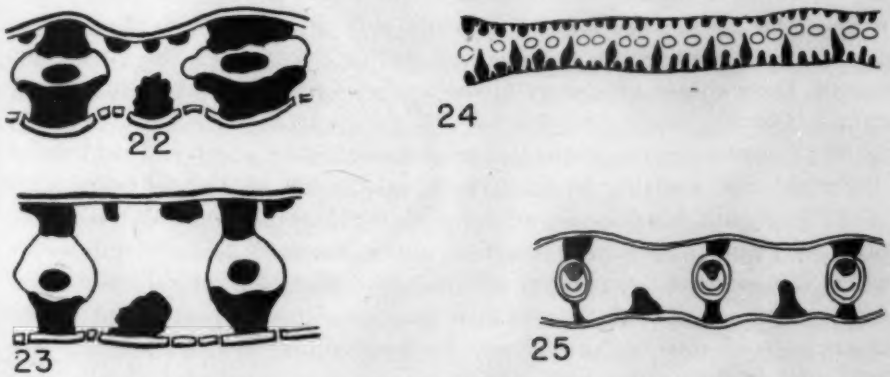


FIGS. 13–21. FIG. 13. Transverse section through the region of a vein. TR-3. FIG. 14. Section through a vein at a higher magnification; this is one of the few veins with any preservation of phloem. TR-7. FIG. 15. Section through the inter-vein region of a leaf showing the small adaxial secondary ribs, and the larger abaxial secondary rib with stomata on either side. TR-3. FIG. 16. Longitudinal section of a leaf. The preservation of this leaf is unusually good; it does not appear to have been subjected to crushing as were most of the leaves, as a result lacunar areas are visible and the palisade parenchyma is delimited from the spongy parenchyma. Furthermore, the cells appear to have retained cytoplasm and nuclei. TR-13. FIG. 17. Longitudinal section through the region of a vein. TR-18. FIG. 18. Metaxylem elements from the former figure showing markings on the walls. FIG. 19. Section through the end of a stoma. TR-15. FIG. 20. Almost median section through a stoma, TR-3. FIG. 21. Longitudinal section through a stomatal row. TR-4.

guard cells (figs. 11, 12). The guard cells are sunken below the level of the epidermis and, therefore, are not visible in surface view. Of the subsidiary cells, the two lateral are shorter and broader than the ordinary epidermal cells, they average about 35–50 micra, while the two terminal ones are nearly oval with average dimensions of 15–25 micra. The stomata are so crowded within the rows that the terminal subsidiary cells are almost invariably shared. Moreover, the rows themselves are so close that the guard cells of neighboring rows often share a lateral subsidiary cell as seen in figure 11.

Internal structure of the leaf. A distinct, fairly smooth layer of cutin surrounds the leaf (figs. 13, 15). The epidermal cells of both surfaces are narrow in cross section, but those of the lower epidermis seem to be somewhat broader and less deep than are the upper epidermal cells. The outer walls of all the epidermal cells are relatively thick, while their radial walls taper gradually toward the inner part of the cell. The cells often contain more or less crescentic masses of opaque material.

As was observed in surface views, the stomata are in groups of two's and three's between the hypodermal bands (figs. 22, 23). Sections through



FIGS. 22–25. Showing the rib patterns of three species of Cordaitean leaves. FIGS. 22, 23. *Cordaites affinis.* TR-3. FIG. 24. *Cordaites crassus.* After Darrah (1940). FIG. 25. *Cordaites principalis.* After Renault (1879).

the stomata show the degree to which the two small oval guard cells are sunken below the level of the epidermis, and also reveal the overhanging thickenings of the lateral subsuduary cells which form a hyperstomatic chamber (figs. 19, 20, 21). The sub-stomatal chambers were rarely visible, possibly because of compression of the mesophyll.

The sections confirm the consistent pattern of distribution and relative position of the primary and secondary ribs as was determined from the surface views and represented diagrammatically in figures 7 and 8. In addi-

tion, they disclose the extent of the development of these sclerotic hypodermal strands within the leaf (figs. 13, 15, 17). The elements of these sclerotic strands are typical fibers. They are elongated cells, their length being about twenty times their width, with oblique end walls. The walls are so thick that the lumen is almost obliterated.

The mesophyll of the leaf is divisible into two general regions: an upper, relatively compact palisade tissue consisting of about four layers of cells; and a lower, lacunar spongy tissue. In sections which are cut perpendicular to the vascular strands, as in figure 15, the palisade cells appear isodiametric and are scarcely to be distinguished from those of the spongy mesophyll. In sections parallel with the vascular strands the palisade character is more pronounced (fig. 16). The leaf of figure 16 is unusual not only for its remarkable state of preservation—the cells appear to have retained their nuclei and cytoplasm—but also the conspicuous lacunar areas indicate a lack of the compression which had flattened most of the leaves and occluded the intercellular spaces giving the mesophyll the appearance of being more compact than it actually was. The seeming greater thickness of this leaf is not to be attributed wholly to lack of compression, but is partly because of the obliquity of the section. In most of the leaves the cells of the spongy parenchyma are small, irregular in shape, and often are observed collapsed and chained together; in a tangential section, taken near the lower epidermis, these chains of spongy tissue are seen preserved as anastomosing strands (fig. 9).

The vascular strands of the leaf are surrounded by a well defined bundle sheath directly abutting on the hypodernal strands above and below (fig. 13). The sheath is composed of large thin-walled elements and is about three cells wide in its broadest portion, narrowing down to one cell in width where it meets the hypodermal strand below. Many of the cells are filled with a dark opaque substance similar in appearance to that found in the sheath cells of some extant Cycads. In longitudinal section bordered pits are found on their radial walls (fig. 17).

One can write with less assurance of the xylem and phloem than of any of the other tissues. The xylem forms an arc extending across the upper portion and down the sides of the phloem (figs. 13, 14). It was not possible to determine the exact position of the protoxylem but it is thought to be mesarch. The metaxylem elements vary considerably in diameter with the largest centered almost invariably in the upper region of the xylem arc. In longitudinal section multiseriate bordered pits, generally in three rows, are seen on the radial walls of the large metaxylem elements (fig. 17, 18), whereas, the more numerous tracheids have sclariform markings. Xylem parenchyma cells are distributed among the lignified elements.

The phloem region is rendered conspicuous because of the non-preserva-

tion of the phloem elements. Occasionally a few of the delicate, thin-walled phloem cells were observed in transverse section as is shown in figure 14.

Relationships. Cordaitean leaves are among the most common plant fossils of the Carboniferous period, both as impressions and compressions and as petrifactions. From the former category many species have been established based upon such characters as: nervation, length, and width. Lesquereux (1880) described 16 species from American coal fields based upon the above superficial characters, nevertheless, of the validity of nervation as a criterion for determination of species he writes: ". . . The nervation of the leaves is the essential character applied to the species determination of *Cordaites*. But as the distance between the primary nerves and the number of intermediate veins vary, not only in leaves of different ages, but even in the same leaf, this character is not entirely reliable." This material demonstrated the impossibility of determining the width of a leaf, hence the number of veins, as seen on the surface of the rock. For the lamina so exposed never exceeded 1.7 cm. while in section many of the leaves were found to be infolded with the maximum actual width, from margin to margin, of 4.6 cm., or more than two and one-half times the width as determined from the surface.

Comparatively few species based on the internal structure of the leaf have been figured and of these there is only one, *Cordaites crassus* Grand' Eury (Darrah, 1940), from American coal fields. This seems to be not because of a lack of structurally preserved material, but rather because of what appears to be a certain anatomical uniformity among them. All the leaves have broad hypodermal bands, which sometimes produce bulging ribs on the surface as in figures 1, 22, 24, and 25; most of them have a fairly well defined bundle sheath enclosing the xylem and phloem, and a mesarch or endarch position of the protoxylem; and, all vary in the proportion of the foregoing structures from one part of the blade to another. Additional criteria used by former investigators to establish species, as thickness of the leaf and distance between the bundles, depend to a great extent upon the degree of preservation.

Cordaites crassus (fig. 24) is also from Iowa and probably from the same horizon as the leaf here considered, yet, a comparison of the distribution and extent of the sclerotic hypodermal strands of the two shows clearly they are specifically different (fig. 22, 24). The anatomy of this leaf most nearly resembles *Cordaites principalis* Germ., described by Renault (1879) and by Stopes (1903), from the Grand 'Croix nodules of the French Stephanian. In the general plan of its sclerotic strands it is almost identical with *C. principalis* (figs. 22, 23, 25). However, in certain other fundamental structures there are some marked differences between the two. Aside from the difference in thickness and distance between the bundles, this leaf does

not have the thick-walled "primitive transfusion tissue" nor are there present the intervening longitudinally elongated layers of cells in the central region as in *C. principalis.*

Florin (1931) has shown that the epidermal and stomatal patterns of fossil leaves may be valuable in specific determination, for the three Cordaitean leaves he considered differed in the size and arrangement of the terminal and lateral subsidiary cells and in the position of the cuticular ridges or papillae on the epidermal cells. If the same criteria were applied to this leaf it would fall into a fourth species.

There were other fragments of Cordaitean origin intermingled with these leaves in the rock. They consisted of bits of wood, buds, pollen sacs with pollen, and seeds; of these only the seeds, *Cardiocarpon affinis* Lesq., have as yet been investigated (Reed, 1946). While the leaves have not been found in organic connection with these fragments it seems highly probable that they may have come from the same plant.

Since this leaf differs in both superficial characters as well as in its anatomy from previously described Cordaitean leaves, and since the leaves are found in rather intimate association in the rock with *Cardiocarpon affinis,* it is described as Cordaites affinis sp. nov.

Description: Cordaites affinis Reed and Sandoe sp. nov. Leaf up to 4.6 cm. wide, with 40–60 parallel veins (rarely dichotomizing) accompanied by ribs of fibrous elements. Between the main ribs of the upper surface are 2 or 3 lesser ones; between those of the lower surface a single but more pronounced rib. Stomata crowded, confined to the inter-rib area of the lower epidermis in 2–5, usually 3, longitudinal rows. Guard cells sunken below the level of the epidermis, surrounded by 4 subsidiary cells; the two lateral subsidiary cells possess overhanging thickenings forming a stomatal chamber. Mesophyll relatively compact, the 3–4 rows of palisade cells scarcely to be differentiated from the spongy parenchyma. Sheath of thin-walled cells surround the vascular tissue. Protoxylem mesarch, metaxylem with scariform, reticulated, and pitted markings.

Locality and horizon: Vicinity of What Cheer, Iowa; Des Moines series of the Upper Carboniferous.

Collector: Dr. L. R. Wilson.

Material: Highly fossiliferous, chocolate brown, somewhat impure limestone with a hackly fracture and a tendency to split into slabs.

Type: Nineteen thin sections, TR 1-19, and two celloidin Peels, TR 21, 22, in the personal collection of Dr. L. R. Wilson of the University of Massachusetts.

SUMMARY

1. A new species of Cordaitean leaf is described from the Des Moines series of the Upper Carboniferous.

2. This is the first description of a Cordaitean leaf which combines the superficial epidermal pattern with the internal anatomy, therefore, despite

the fact there is no hint as to its length, it is perhaps the most completely known species.

3. When compared with previously described leaves of the genus the leaf was found to differ in specific details, it is accordingly assigned to a new species—*Cordaites affinis* sp. nov.

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BULLETIN OF THE TORREY BOTANICAL CLUB

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A UNIQUE VEGETATIONAL AREA IN TAMAULIPAS

EFRAÍM HERNÁNDEZ X.,[1] HOWARD CRUM, WM. B. FOX AND A. J. SHARP[2]

The presence of temperate plants in the vegetation of eastern Mexico was recognized by Fernald (1931) and was later discussed in some detail by Miranda and Sharp (1950). Mr. Byron Harrell of the University of Minnesota recently called the attention of the last-named author to a northward extension of the known range of mixed tropical and temperate vegetation into the Sierra de Guatemala[3] of Tamaulipas. We have visited this area and feel that a preliminary description is warranted.

Reached only by tortuous, steep, rocky trails on the slopes of the Cerro del Tigre from Gómez Farías, or from the ranch of Sr. E. W. Storms north of El Limón, there is a forest which seems unique in floristic composition and in many ways suggestive of the past when "temperate" and "tropical" genera may have grown side by side over large areas in North America, as suggested by Sharp (1951).

At about 3500 feet near Frank Harrison's "Rancho del Cielo" one may see huge buttressed oak trees growing with *Liquidambar styraciflua, Magnolia Schiedeana,* and *Acer Skutchii* (closely related to *A. saccharum*) all of which are festooned with such tropical mosses as *Pilotrichella rigida, P. flexilis, Meteoriopsis patula, Papillaria nigrescens, P. Deppei* and *Meteorium illecebrum,* and heavily covered with orchids and bromeliads. Equally decorated are the trees of *Clethra macrophylla, Podocarpus Reichei, Taxus globosa* and such tropical genera as *Turpinia, Lonchocarpus, Chamaedorea* and *Trichilia.* The mixture of species whose centers of distribution lie far to the north with those whose centers lie far to the south is truly amazing.

The finest development of the forest seems to be near Harrison's ranch on a thoroughly dissected limestone plateau with karst topography. The area is so well-drained that creeks and springs are almost non-existent in spite of the heavy rainfall and frequent fogs. The soil is black and apparently rich in humus; upon drying it forms large granules. It erodes readily and is relatively shallow except where it accumulates in sinks and crevices of the limestone. Due to the height of Cerro del Tigre which rises

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[2] Contribution from the Botanical Laboratory, The University of Tennessee, N. Ser. 128.

[3] Name applied to the mountain mass in ancient property maps. The local name is Sierra de Cucharas.

to about 8000 feet to the west of the plateau, the annual precipitation is heavy and evidently varies between about 70 and 100 inches per year.

Although there is no well-defined dry season, (according to Mr. Harrison) the period from September to May is drier than the remaining months which may have very heavy precipitation. During the drier period many days are foggy or have cool, drizzly rains. Even heavy showers may occur, particularly from February until May when the rains begin "in earnest." Mr. Harrison has lived there since 1935 and some of the time has kept crude climatological (temperature, rainfall and frost) data. The lowest minimum recorded is 28° F. and the highest maximum, 92° F. He remarks that one or more frosts are expected each year, but, as elsewhere in parts of North America, the last two years (1948–1950) were unusual (without frost and with extremely low precipitation). It should be noted that for some distance both north and south of this sierra (fig. 1) the annual precipitation is meagre and the vegetation essentially of a xeric nature.

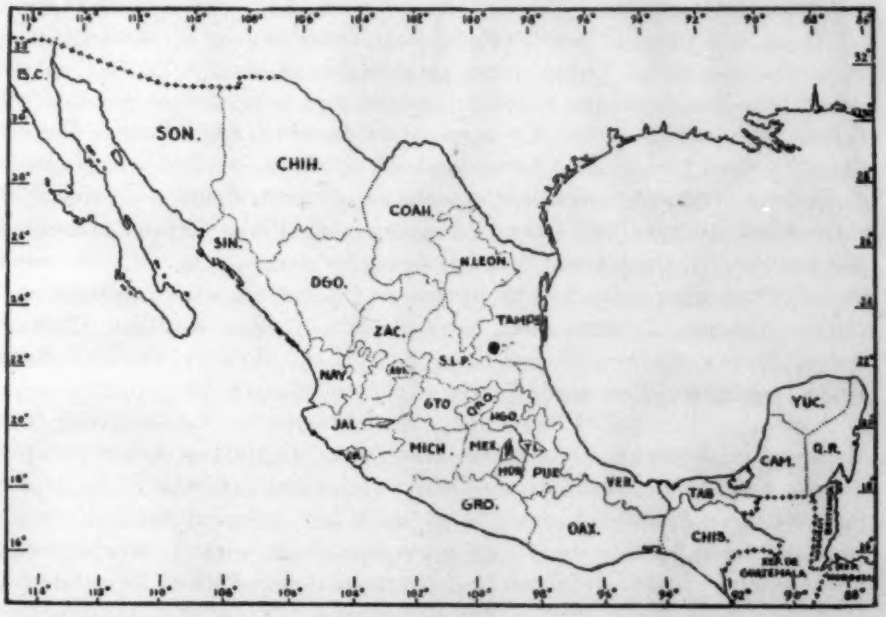

FIG. 1. The dot in Tamaulipas marks the approximate location of the Sierra de Guatemala.

Oaks are the dominant trees near Harrison's ranch and probably no less than five species are represented. *Liquidambar styraciflua* appears second in abundance, followed by *Clethra macrophylla, Magnolia Schiedeana, Podocarpus Reichei, Acer Skutchii* and *Carya* (probably two spp. in the *C. ovata* complex).

In a 25 acre area about 100 genera were noted. Included were such "northern" species as *Cercis canadensis* (often attaining a height of more than 50 feet and a foot in diameter), *Rhamnus caroliniana, Rhus radicans, R. canadensis, Parthenocissus quinquefolia, Smilax glauca, Gelsemium sempervirens, Hamamelis virginiana, Prunus serotina, Mitchella repens, Phytolacca americana, Arisaema dracontium, Conopholis americanus, Botrychium virginianum, Polypodium polypodiodes,* and such "northern" genera as *Tilia, Morus, Cornus, Vitis, Elephantopus, Sanicula* and *Agrimonia.* These are mixed with such "southern" genera and species as *Turpinia pinnata, Bocconia arborea, Trichilia havanensis, Osmanthus, Eugenia, Leucaena, Chamaedorea, Xylosma, Cnidoscolus, Gilibertia, Achimenes, Bomarea, Piper, Peperomia, Begonia, Tillandsia* and others. The following genera were also observed: *Wimmeria, Ilex, Mahonia, Persea, Lonchocarpus, Diospyros, Decatropis, Xanthoxylum, Solanum, Solandra, Dahlia, Croton, Juglans, Garrya* and others. A more complete list of specific determinations will be published later.

There is a stand of beech (*Fagus mexicana*) nearby at Indian Spring (Ojo de Agua de los Indios) with an elevation of about 5000 feet. Associated with the beech the following species and genera were noted in the field in an area of less than five acres: *Acer Skutchii, Liquidambar Styraciflua, Illicium floridanum, Taxus globosa, Podocarpus Reichei, Magnolia Schiedeana, Cercis canadensis, Carpinus caroliniana, Prunus serotina, Parthenocissus quinquefolia, Rhus toxicodendron, Pinus patula, Adiantum capillus-veneris, Cystopteris fragilis, Arisaema dracontium, Laportea canadensis, Phytolacca americana, Epifagus virginiana, Quercus* (several spp.), *Carya, Mahonia, Xanthoxylum, Vitis, Smilax, Cornus, Rapanea, Chamaedorea, Persea, Clethra, Desmodium, Senecio* (2 shrubby spp.), *Lobelia, Viola, Achimenes, Prestonia, Cassia, Piper* and *Galium.*

Several of the species listed above are recorded for the first time from Mexico, e.g., *Rhamnus caroliniana, Hamamelis virginiana, Laportea canadensis,* and *Rhus canadensis.* Others represent extensions in known ranges. *Acer Skutchii* had not been previously reported north of Guatemala and upon further study may prove conspecific with *A. brachypterum* to the north. *Fagus mexicana* had not been reported from any state but Hidalgo. *Podocarpus Reichei* was not known north of Xilitla, San Luis Potosí. In contrast it is surprising that no *Ficus* or *Nyssa* or member of the Melastomaceae were seen.

Toward Agua Zarca on the trail to Joya de Salas the broad-leaved genera became less abundant and pines (*Pinus montezumae* and *P. patula*) increase rapidly in frequency near 5000 feet with *Abies* occasional on the more moist sites.

As yet the forests of the region have been little damaged by fire or lum-

bering or pasturing, and in view of their beauty and unique composition, they should be preserved for posterity.

The mosses were rather carefully collected in the region, and the list includes seventy-six species of mosses, all first records for the state of Tamaulipas. Two species are reported as additions to the Mexican moss flora. The classified list is presented below.

Species new to Mexico: *Fissidens limbatus* Sull. Range: Vancouver Island and Alberta to New Mexico; Mexico; Puerto Rico. *F. subbasilaris* Hedw., determined by Dr. W. C. Steere. Range: Widely distributed in eastern North America from Ontario to Florida and west to Oklahoma.

Tropical and sub-tropical species not reported from north of the Rio Grande: *Holomitrium arboreum* Mitt., *Leucoloma cruegeriana* (C. M.) Jaeg., *Leucobryum polakowskyi* (C. M.) Card., *Syrrhopodon gaudichaudi* Mont. (*S. inflexus* Mitt.), *Pseudosymblepharis circinatus* (Schimp.) Broth., *Bryum procerum* Schimp., *Groutiella fragilis* (Mitt.) Crum & Steere, *G. wagneriana* (C. M.) Crum & Steere, *Macromitrium fragilicuspis* Card., *M. pentastichum* C. M., *Schlotheimia sublaevifolia* C. M., *Prionodon densus* (Hedw.) C. M., *Trachypus viridulus* (Mitt.) Broth., *Orthostichidium pentagonum* (Hampe & Lor.) C. M., *Pterobryopsis mexicana* (Schimp.) Fleisch., *Pterobryum densum* (Schwaegr.) Hornsch., *Meteorium illecebrum* (C. M.) Mitt. form, *M. teres* Mitt., *Papillaria deppei* (Hornsch.) Jaeg., *P. imponderosa* (Tayl.) Broth., *Pilotrichella flexilis* (Hedw.) Jaeg., *P. rigida* (Hedw.) Jaeg., *Homaliodendron mohrianum* (C. M.) Fleisch., *Neckera urnigera* C. M., *Porotrichum cobanese* C. M., *Lepidopilum pringlei* Card., *Thuidium antillarum* Besch., *Platyhypnidium subrusciforme* (C. M.) Fleisch., *Entodon erythropus* Mitt., *Isopterygium diminutivum* Bartr., *Mittenthamnium reptans* (Hedw.) Card., *Rhaphidorrhynchium insularum* (Sull.) Broth., *R. lindigii* (Hampe) Broth., *Sematophyllum sericifolium* Mitt., *Atrichum polycarpum* (C. M.) Schimp.

Tropical or subtropical species which occur in the coastal lowlands of southeastern United States (some of these species also occur in southwestern United States just across the Mexican border): *Fissidens donnellii* Aust., *F. repandus* Wils, *Syrrhopodon incompletus* Schwaegr., *S. prolifer* Schwaegr., *Brachymenium systylium* (C. M.) Jaeg., *Rhizogonium spiniforme* (Hedw.) Brid., *Pireella ludoviciae* (C. M.) Card., *Meteoriopsis patula* (Hedw.) Broth., *Papillaria nigrescens* (Hedw.) Jaeg., *Neckeropsis undulata* (Hedw.) Beichd., *Sematophyllum caespitosum* (Hedw.) Mitt., *Taxiphyllum planissimum* (Mitt.) Broth., *Mittenothamnium diminutivum* (Hampe) E. G. Britt.

Typical Mexican species which extend into southwestern United States: *Timmiella anomala* (Bry. eur.) Limpr., *Trichostomum brachydontium* Bruch, *Ptychomitrum serratum* Bry. eur.

Species widely distributed to eastern United States with a disjunct Mexican distribution: *Fissidens cristatus* Wils., *Campylopus flexuosus* (Hedw.) Brid., *Hyophila tortula* (Schwaegr.) Hampe, *Trichostomum cylindricum* (Bruch) C. M., *Tortella humilis* (Hedw.) Jenn., *Schlotheimia rugifolia* (Hook.) Schwaegr., *Fabronia ciliaris* (Brid.) Brid., *Anomodon attenuatus* (Hedw.) Hueben., *Herpetineurum toccoae* (Sull. & Lesq.) Card., *Thuidium delicatulum* (Hedw.) Mitt., *T. minutulum* (Hedw.) Mitt., *Entodon macropodus* (Hedw.) C. M.

Species restricted in southeastern United States to the Southern Appalachian region: *Leptodontium squarrosum* (Hook.) Par. (*L. excelsum* of American authors), *Funaria hygrometrica* var. *calvescens* (Schwaegr.) Bry. eur., *Bryum truncorum* Brid., *Macrocoma hymenostoma* (Mont.) Grout, *Pleuropus bonplantii* (Hook.) Broth.

Cosmopolitan species: *Weisia controversa* Hedw., *Bryum argenteum* Hedw., *B. capillare* Hedw., *Mnium longirostrum* Brid.

Some of the lichens in the oak-sweet gum forest were collected. Among them were found: *Anaptychia hypoleuca* (Mubl.) Mass., *A. leucomela* (L.) Mass., *Cladonia furcata* var. *pinnata* (Flk. Vainio,[4] *Parmelia aurulenta* Tuck., *P. Borreri* Turn., *P. caperata* (L.) Ach., *P. cetrata* Ach., *P. perforata* (Wulf.) Ach., *P. sulphurata* Nees & Flat., *Peltigera polydactyla* var. *typica* (Neck.) Hoffm., *Pertusaria leipolaca* (Ach.) Lam., *Physcia stellaris* (L.) Nyl., *Ramalina complanata* (Swartz) Ach., *R. farinacea* (L.) Ach., *Sticta quercizans* Ach., *Theloschistes chrysophthalamus* (L.) Beltr., *T. flavicans* (Swartz) Norm., *Usnea florida var. strigosa* Ach. and *U. dasypoga* (Ach.) Rohl. All listed above range northward, some as far as Canada.

In the oak-sweet gum forest, the following fungi were among those collected: *Auricularia polytricha* (Mont.) Sacc., [5]*Chlorocibaria aeruginascens* (Nyl.) Kanouse, [5]*Daldinia concentrica* (Balt. ex Fr.) Ces. & DeNot., *Favolus braziliensis* Fr., [5]*Fomes australis* Cke., [5]*Hygrophorus conicus* Fr., [5]*Lactarius indigo* Schw., *Merulius tremellosus* Schr. ex Fr., [5]*Polyporus adustus* Willd. ex Fries., [5]*P. cinnabarinus* Jacq. ex Fr., *P. fimbriatus* Fr., [5]*P. gilvus* Schw. ex. Fr., *P. maximus* (Mont.) Overh., *P. rhipidium* Berk., *P. tabacinus* Mont., *P. tenuis* Sacc., [5]*P. versicolor* Fr., [5]*Schizophyllum commune* Fr., [5]*Xylaria cubensis* Mont. In addition [5]*Collybia radicata* Fr. and [5]*Polyporus sulfureus* Fr. were noted in the field.

Agaricaceae seem poorly represented and according to Mr. Harrison are never abundant. Polyporaceae and Thelephoraceae are much more common.

[4] Otherwise known only from eastern United States. Thanks are due Dr. Hugh N. Mozingo for determinations.

[5] Also found in Eastern United States (Cf. Sharp, 1948). Thanks are due Miss Edith Cash, Dr. L. R. Hesler, Dr. Julian Miller and Dr. J. A. Stevenson for the determinations.

One night during a heavy shower, outlines of the forest trail could be discerned easily by contrast with luminescent decaying leaves and logs, acres in extent.[6]

SUMMARY

1. The vegetation in the mountains above Gómez Farías, Tamaulipas, México, consists of "temperate" species (*Fagus mexicana, Acer Skutchii, Liquidambar styraciflua,* and others) mixed with "tropical" species (*Trichilia havanensis, Turpinia pinnata, Bocconia arborea, Chamaedorea* sp., *Eugenia* sp. and others).

2. Reported for the first time from Mexico are: *Hamamelis virginiana, Rhamnus caroliniana, Rhus canadensis, Laportea canadensis* and certain mosses, lichens and fungi.

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[6] After this paper was in the press, Mr. Harrison wrote that on the night of Feb. 1, 1951, the thermometer registered 23° F. for a short while and froze several tropical species to the ground.

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TORREYA

A PRELIMINARY REPORT ON THE VASCULAR FLORA AND VERTEBRATE FAUNA OF THE BLUFFS NORTH OF MILFORD, N. J.

DAVID FABLES AND LAUREL HOUDA

The sandstone and shale bluffs north of Milford, Hunterdon County, N. J. rise up from the Delaware River like a West Jersey palisade. The plants growing on these bluffs often hang tenaciously to crevices in the rocks for their very existence. All identified vascular plants and the resident or breeding vertebrates of the area were included in a survey made during the 1950 season.

Description of Area. The region covered by this report is approximately two miles in length and extends back from the road, which parallels the river, some two hundred yards. A single gravel road climbs over the bluffs at a point somewhat more than a mile north of Milford. We covered the area adjoining this road to the summit of the bluff. There are several places where trickling rivulets spill down over the ledges to the road level, and thence flow under the road to the river below. One attractive waterfall is hidden some fifty yards back from the road, the water-splashed rocks at its base being covered with liverworts.

Perhaps the most unusual floral display is that of the prickly pear cactus (*Opuntia humifusa* Raf.) which grows so abundantly on the overhanging ledges, covering them with a yellow bloom in July. To date, in our searching, more than forty clumps of the hairy lip fern have been found, some of them eeking out an existence on virtually barren rock. Atop the bluffs are numerous Jersey pines (*Pinus virginiana*), seemingly out of place to one accustomed to observing them on the flat Coastal Plain to the south.

To see the Milford bluffs at their finest one should visit them in late April or early May, when the first real burst of lasting warmth has brought out the delicate spring flora which carpets the ground and rocks, when the lichens and mosses are still conspicuous and before the advent of most leaves.

Geology. A very unusual interfingering of shale, sandstone and conglomerate dating from the Triassic occurs. The area is unglaciated. Reference to *Bulletin #50, State Geologic Series, The Geology of New Jersey* would give the reader a complete picture of the formations found beneath the existent flora and soil. The interbedding of conglomerate with shale and sandstone makes a very attractive pattern, especially when the deep red tones of the cliffs are brightened by the vivid greens and yellows of the mosses and lichens. Much of the charm of the region can be attributed to the layering of successive deposits of shale and sandstone.

Characteristic Flora. Space does not permit the listing of all species identified thus far. Complete lists may be obtained upon request from the authors. The species mentioned in our summary were the ones most typical of each season. They are arranged in taxonomic order. The scientific names of the flora are those of *Gray's Manual of Botany*, Eighth Edition, 1950.

Spring. Undoubtedly the prettiest season at the bluffs is spring. The delicate flora of that season bloom profusely from rock fissures, roadsides, rivulet banks and on the exposed ledges. As one walks along their base or climbs upon the ledges, the eye frequently falls upon: spring beauty (*Claytonia virginica*), bloodroot (*Sanguinaria canadensis*), hepatica (*Hepatica americana*), Dutchman's breeches (*Dicentra Cucullaria*), rue anemone (*Anemonella thalictroides*), wood anemone (*Anemone quinquefolia*), early saxifrage (*Saxifraga virginiensis*), alumroot (*Heuchera americana*), two-leaved crinkleroot (*Dentaria diphylla*), cut-leaved crinkleroot (*D. laciniata*), early woodland crowfoot

(*Ranunculus fascicularis*), round-leaved yellow violet (*Viola rotundifolia*), green violet (*Hybanthus concolor*), lyre-leaved rock cress (*Arabis lyrata*), yellow pimpernel (*Taenidia integerrima*), moss pink (*Phlox subulata*), horse gentian (*Triosteum perfoliatum*), pussy toes (*Antennaria canadensis*). Attractive as the flowers are, one's attention is freqeuntly diverted to a black-throated green or a Blackburnian warbler passing through the trees overhead, or to the song of the Louisiana water-thrush cascading downhill with the waters of the streams.

Summer. June and July finds the prickly pear cactus in a profusion of bloom that would rival the desert species. It is easily overlooked by casual passers-by, for it grows far above their heads on the exposed bluffs. While in full bloom its beauty en masse equals that of many better-publicized species. Summer does not measure up to spring at the bluffs, but the breeding birds fill any gap which develops in the flora. The phoebe still nests in its ancestral manner on a convenient shale ledge, shunning the bridges used by more "modern" individuals. On two occasions a flame-colored scarlet tanager was observed. Ruby-throated hummingbirds are to be seen visiting the Oswego tea. From thickets along the road, and more rarely from the ledges overhead, comes the "tea-kettle, tea-kettle, tea-kettle" of the Carolina wren. Prominent among the herbs and low shrubs at this season are: purple-flowered raspberry (*Rubus odoratus*), Carolina rose (*Rosa carolina*), Virginia creeper (*Parthenocissus quinequefolia*), orange milkweed (*Asclepias tuberosa*), bee balm (*Monarda didyma*), bush honeysuckle (*Diervilla Lonicera*).

Autumn. There are no extensive floral displays on the bluffs as are seen in the fields during this season, but the blue flowers of *Lobelia syphilitica* cluster attractively in the wetter spots along the roads. The number of species of asters, goldenrods and eupatoriums is rather large, although the plants do not abound. Vying for position at this season are: blue lobelia (*Lobelia syphilitica*), hoary mountain mint (*Pycnanthemum sp.*), woodland sunflower (*Helianthus divaricatus*), ironweed (*Vernonia noveboracensis*), white snakeroot (*Eupatorium rugosum*), sharp-leaved goldenrod (*Solidago arguta*), blue-stemmed goldenrod (*S. caesia*), late purple aster (*Aster puniceus*), New England aster (*A. novae-angliae*). In the lists which follow we have included only the conspicuous trees and shrubs, and the most commonly observed grasses, sedges and rushes, mostly autumnal species. The list of pteridophytes is complete as far as our present observations extend.

Conspicuous Trees and Shrubs. Jersey pine (*Pinus virginiana*), tulip tree (*Liriodendron Tulipifera*), basswood (*Tilia americana*), slippery elm (*Ulmus rubra*), chestnut oak (*Quercus prinus*), red oak (*Q. rubra*), black oak (*Q. velutina*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), white sassafras (*Sassafras albidum*), black cherry (*Prunus serotina*), hackberry (*Celtis occidentalis*), ironwood (*Carpinus caroliniana*), witch hazel (*Hamamelis virginiana*), staghorn sumach (*Rhus typhina*), poison ivy (*R. radicans*), black haw (*Viburnum prunifolium*), ninebark (*Physocarpus opulifolius*).

Conspicuous Grasses, Sedges and Rushes. Yellow fox-tail grass (*Setaria glauca*), red top (*Triodia flava*), hispid panic grass (*Panicum clandestinum*), bottle-brush grass (*Hystrix patula*), purple love grass (*Eragrostis pectinacea*), straw-colored sedge (*Cyperus strigosus*), dark-green bull rush (*Scirpus atrovirens*).

Pteridophytes. Rattlesnake fern (*Botrychium virginianum*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis* var. *spectabilis*), bracken (*Pteridium aquilinum* var. *latiusculum*), hairy lip fern (*Cheilanthes lanosa*), sensitive fern (*Onoclea sensibilis*), hay-scented fern (*Dennstaedtia punctilobula*), ebony spleenwort (*Asplenium platyneuron*), maidenhair spleenwort (*A. Trichomanes*), silvery spleenwort (*Athyrium thelypteroides*), brittle fern (*Cystopteris fragilis*), blunt-lobed cliff fern (*Woodsia obtusa*), marginal shield fern (*Dryopteris marginalis*), New York fern (*D. noveboracensis*), marsh fern (*D. palustris*), Christmas fern (*Polystichum acrostichoides*), rock polypody (*Polypodium virginianum*), field horsetail (*Equisetum arvense*).

Many of the above species were listed by Britton in his *Catalogue of the Plants of New Jersey*—1889, as occurring at Milford. Apparently the passing years have treated them kindly, for the majority of them can still be located.

Vertebrates. No fish were observed, but this is to be expected, in view of the absence of permanent water. Among the amphibia the gray tree frog (*Hyla versicolor*) and the red-backed salamander (*Plethodon cinereus*) alone were observed, though other species probably occur. The reptilian class is thus far represented by the box tortoise (*Terrapene carolina*). Birds dominate the vertebrate picture and a rather sizable list of the breeding species or potential breeding species was obtained. Migrants observed were not included in the list. In addition to the 28 species listed as residents, a pileated woodpecker was observed in the area, though it probably was not breeding. The species recorded are based mainly upon the consistent presence of singing males during the breeding season, although nests of the phoebe, rough-winged swallow, blue jay, catbird, robin, wood thrush, red-eyed vireo and song sparrow were found. The complete list of resident species follows: yellow-billed cuckoo, ruby-throated hummingbird, flicker, downy woodpecker, crested flycatcher, phoebe, wood pewee, rough-winged swallow, blue jay, eastern crow, Carolina wren, catbird, brown thrasher, robin, wood thrush, veery, red-eyed vireo, black and white warbler, ovenbird, Louisiana water-thrush, redstart, scarlet tanager, indigo bunting, goldfinch, red-eyer towhee, chipping sparrow, field sparrow and song sparrow. The Carolina wren sang frequently, but in typical fashion managed to remain out of sight most of the time in brushy thickets. The species is not often found along the Delaware this far north. A racoon (*Procyon lotor*), woodchuck (*Marmota monax*) and gray squirrel (*Sciurus carolinensis*) were the only mammals noted, but this must be considered an incomplete list as no trapping was employed, nor any evening trips undertaken.

The bluffs today must be almost as unspoiled as in the days of the redman. We can climb to their summit at eventide and witness the sun's rays fall upon the trees, sandstone and water below, capturing in a small measure some of the feeling that must have come to the aborigine who preceded the "paleface" to this attractive region.

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Kummel, H. B. 1940. The Geology of New Jersey.

Field Trip Reports

May 18–20. Nature Conference. Sparta, N. J. In its 37 years of operation the the annual spring nature conference has lost the use of The Pines and now of the Haltere through changes in management and policy. This year accommodations were found at Manor Farm Hotel at the end of Lake Mohawk. This location gave the group much new territory to explore although some trips were scheduled to familiar areas at Culvers Lake, Stokes Forest, and the Pines. As usual, the attendance overflowed the facilities.

Those present and those who have attended in other years appreciate the devotion and graciousness with which Mr. Wallace Husk has met the problems of accommodations. No less devoted has been Mr. James Hawley's attention to details of the program for these busy days. Every year he has enlisted an amazing array of instructors whose services would ordinarily command a high remuneration from the "customers." This year he brought Mr. Charles Broley of Delta, Ontario, and Tampa, Florida, a leading authority on eagles. In addition to lecture, movies, and demonstration there was the valuable informal association with this fine gentleman and his gracious wife.

Another specialist presented was Mr. Carl B. Cranmer of the State Department of Conservation and Economic Development who provided an illustrated lecture and field trips to various localities of forested aspect. A total of 49 woody species were recorded. Trips for flowering plants, ferns, mosses, and lichens were conducted by Mr. Louis Hand and Mr. Guy Nearing. No counts or lists were reported but all of the students were satisfied.

Birds are a must at the conference. Our leaders were Mr. and Mrs. J. W. Hand, Mr. and Mrs. C. B. Schaughency, and Mr. David Fables. The meadows, orchards, swamps, and woodlands available were ideal for the purpose and a list of 118 positively identified species was compiled.

In spite of unfavorable weather and the great difficulties in finding accommodations, this 37th annual conference marked a high spot in the botanical and ornithological year for all who attended. So, applause and orchids to that unbeatable team—Hawley & Husk. Total attendance, 92.

May 26. High Point State Park, N. J. While on our trip we noted the changes which had taken place in the beaver swamp near Saw Mill Pond, High Point, between May 1950 and May 1951. More trees had been killed, the green frog (*Rana clamitans*) population had swelled and wood ducks and red-winged blackbirds had arrived as breeding species. The "big blow" of late November 1950 had toppled may of the ancient hemlocks in the Cedar Swamp at High Point, adding confusion to the already impenetrable thickets formed by the rhododendrons. Among the more conspicuous and attractive members of the flora in bloom were: hop-like sedge (*Carex lupulina*), northern jack-in-the-pulpit (*Arisaema Stewardsonii*), wild calla (*Calla palustris*), perfoliate-leaved bellwort (*Uvularia perfoliata*), yellow Clintonia (*Clintonia borealis*), three-leaved Solomon's seal (*Smilacina trifolia*), painted trillium (*Trillium undulatum*), blue flag (*Iris versicolor*), pink lady's slipper (*Cypripedium acaule*), northern coral-root (*Corallorhiza trifida*), flowering wintergreen (*Polygala paucifolia*) and dwarf dogwood (*Cornus canadensis*). The leader's two-year old nephew started his botanical career by learning to identify the blue lupine (*Lupinus perennis*) which was in profusion along Ridge Road. Attendance 4. Leader: David Fables.

June 17. Van Cortlandt Park, N. Y. The leader, Miss Jane Meyer, wishes to express her disappointment in not being able to meet (or notify) the group because of the sudden illness of a member of her family.

June 18–21. White Mountains, N. H. This trip was associated with the Fifth Annual Field Excursion of the Botanical Society of America, Northeastern Section. The assembly point and headquarters was the Glen House in Pinkham Notch. Eight states and the Province of Quebec were represented. The program was arranged by the Department of Botany of Dartmouth College.

On Tuesday (19th) the group rode to the summit of Mt. Washington (6288 ft. elev.) to begin a field trip. Objective for the day was the study of flora above timberline. After inspecting the weather station on the summit, where the resident observer explained recording methods and related some facts about the unusual weather that occurs there, the group proceeded under the leadership of Dr. Stuart K. Harris to Lake of Clouds Hut, thence across Bigelow Lawn, Alpine Garden, top edge of Huntington Ravine and ending the trip at the Carriage Road at approximately 2 miles below the summit. The entire day was spent above the 5000 ft. mark and many rare or uncommon plants were seen. Of especial interest were *Potentilla Robbinsiana*, *Houstonea caerulea*, var. *Faxonorum*, *Geum Peckii*, and *Saxifraga rivularis*. All of these were seen in flower though most of the *Geum Peckii* were still budded. *P. Robbinsiana* is an endemic of the White Mts., while the others occur in eastern U. S. only in the White Mts. The fine display of Lapland rosebay (*Rhododendron lapponicum*) and of *Diapensia lapponica* still in flower due to the late season were admired by all. Less spectacular but no less typical plants included *Lycopodium Selago*, *L. annotinum* var. *pungens*, *Juncus trifidus*, *Scirpus caespitosus*, *Hierochloe alpina*, *Polygonum viviparum*, *Salix planifolia*, *S. argyrocarpa*, *S. Uva-ursi*, *S. herbacea*, *Betula glandulosa*, *Arenaria groenlandica*, *Loiseleuria procumbens*, *Vaccinium Vitis-Idaea* var. *minus*, and *Lonicera villosa*. Along the descending Carriage Road were seen patches of *Cornus canadensis*, *Ledum groenlandicum*, *Clintonia borealis* and *Amelanchier Bartramiana*, all in flower.

Considerable snow was still lying in the ravines and one skier was enjoying the snowbank in Tuckerman's. Dr. Harris, a former hutmaster in various camps of the Presidential Range, proved an excellent leader and guide and his interesting facts con-

cerning history, plant and animal life, weather conditions, etc., were greatly enjoyed by the group. In the evening Dr. Arthur S. Pease, Emeritus Prof. of Latin, Harvard, and author of "Flora of Coos Co., N. H.," spoke on the history of botanical exploration in the White Mts. tracing the exploration, both geographical and botanical, from the earliest visitors to recent times. Many of the plants, streams, and other features are named after such pioneers as Biglow, Oakes, Tuckerman, Huntington, Cutler, Boott, Faxon, Robbins, etc.

On Wednesday, under the leadership of Dr. Pease, an all day trip was taken to study bog and other types of plant habitats. Bogs and open ponds in the Shelburne, N. H., region yield *Calla palustris, Menyanthes trifoliata, Kalmia polifolia, Vaccinium Oxycoccus, Glyceria borealis, Rhododendron canadense,* etc. Open fields and thickets have *Penstemon pallidus, Potentilla tridentata, P. arguta, Populus tremuloides* var. *magnifica,* and *Lycopodium sabinaefolium.* Stops were also made at Evans Notch, Maine; Cold River Camp, N. H.; then by Fryeburg, Maine, to N. Conway, N. H.; and back to Pinkham Notch where Glen Ellis Falls and Crystal Cascade were visited both for scenery and plants. *Streptopus amplexifolius, Polystichum Braunii* and *Dryopteris fragrans* were seen there. The evening program consisted of an illustrated lecture "Plants of Mt. Washington" by Dr. Harris.

On Thursday, under Dr. Harris, first stop was Mt. Prospect State Park (N. H.) at elev. 2059 ft., reached by gravel road from N. H. Route 3 a few miles below Lancaster. Notable plants: *Geum rivale, Picea glauca, Veronica chamaedrys, Carum Carvi, Carex flava, Scirpus rubrotinctus, Equisetum scirpoides,* and an Ascomycete—*Exoascus pruni* —parasitic on *Prunus nigra.* The other stop was at Stark, N. H. to study the talus slope of Devil's Slide. *Clematis verticillaris, Selaginella rupestris, Woodsia ilvensis,* and *Polypodium virginianum* forma *acuminatum* were the new plants seen.

This officially ended the excursion but those staying overnight were rewarded with a kodachrome lecture by Dr. Mildred Faust of Syracuse University reviewing the Section's 1947 trip (Gaspe), 1948 trip (N. J.), and the 1950 Stockholm Botanical Congress plus a fine series of Lapland pictures.

Reports of earlier trips by this Section may be found in the BULLETIN as follows: 1947 (Gaspe), Vol. 74, p. 520; 1949 (Michigan), Vol. 77, p. 47.—Louis E. Hand.

July 7, 1951. Roselle, New Jersey. Members of the Torrey Botanical Club and the New Jersey Section of the American Fern Society enjoyed a very profitable afternoon at the fern garden of Mr. W. D. Mann. The garden contains most of the English Crested varieties which in themselves make a lovely display. Attendance 18. Leader, W. D. Mann, Jr.

July 22, 1951. Tucker's Cove and Vicinity, Shark River Hills, N. J. We assembled at Brighton Ave. and Lakewood Road and then visited the marsh at the left of Brighton across Shark River Bridge and inland side of River Road. We saw purple milkweed, steeple bush, monkey flower, spotted touch-me-not, vervain, and poison hemlock. After lunch we went down Overlook to Hillside, finding a nice stand of pyxie (past blooming), meadow beauty, white fringed orchid, pinkstar and butterfly weed in bloom. Attendance 4. Leader, Ralph Armstrong.

July 29. Allaire State Park, Monmouth County, N. J. Only six braved the weather for this Allaire trip but the sun shone in the afternoon and the trip was voted a success. The highlight was the bridge over the Manasquan near Farmingdale. Standing on the bridge and looking down on the river edge and flood plain it was possible to count fourteen species of herbaceous plants in bloom. Fifteen species of trees or shrubs could be seen from the same spot, and twelve more species of flowering plants in bloom were found in less than one hundred yards. Does anyone know a more prolific spot? Attendance 6. Leader, V. L. Frazee.

August 5. Whitesbog, New Jersey. Torreys on the Whitesbog trip were well repaid for their trip. Mr. Frazee as usual showed the four exotic trees in Point Pleasant. Lunch was eaten in a shady spot along the road and we reached Miss White's a little

after one, where Miss Vail took charge. We spent a lot of time in Miss White's wonderful garden. This is the only place known where *Lygodium* is a troublesome weed. The *Franklinia* had not reached its peak but one large tree, one of the original at Whitesbog, was in full bloom and was magnificant. Miss Vail gave a complete and entertaining description of the hybridizing and selection of blueberries. Of one particular cross over three thousand seedlings were grown to bearing age and then all but two were discarded. We saw the rare and interesting *Breweria*. Miss White and Miss Vail have turned the blueberry work over to the government and have taken up the propagation and hybridizing of holly. He saw some twenty or thirty thousand plants. We ended by going to see Rattlesnake Ace. We welcomed us and showed us his pets. One was a six foot pine snake. His rattler was left serenely in his box but sang lustily for us. Attendance 7. Leader, Miss June Vail.

August 12. Carnarsie, Brooklyn, N. Y. About seventy five beach and weed plants were found in flower. The pine barren sandwort and the golden aster proved to be of special interest. A large number of big puff balls (*Calvatia cyanthiformis*) were found in a field and were collected by a number of gourmets present. For those interested in birds, the black skimmers and three upland plovers were outstanding sights. Attendance 19. Leader, Emanuel D. Rudolph.

August 19. Sims Place in the Pine Barrens, New Jersey. The Sims Place trip was much as usual. Nothing was found that had not been seen on previous trips but there were several new people and the exclamations that this was the first time that they had seen this or that were numerous. The stand of *Habenaria integra* seems to be flourishing and barring "improvements" bids fair to be there for years. As we came out we stopped at the sphagnum place but unfortunately there was none drying. Then we stopped at Cranmer's turkey ranch at Warren Grove where we saw three thousand Thanksgiving and Christmas dinners in the making. A short trip into the plains introduced many of us to that interesting phenomenon. Attendance 16. Leader, V. L. Frazee.

Note

The American Association for the Advancement of Science will meet in Philadelphia from Wednesday, Dec. 26, through Sunday, Dec. 30. There will be sessions for botanical papers on Friday all day and Saturday afternoon. There will be a symposium of Radiobotany on Saturday morning, on Foods and People on Sunday morning, on the Pine Barrens and also on Visual Education on Sunday afternoon, and on Ecology of Disturbed Lands on Sunday evening. The Philadelphia Botanical Club will hold a special meeting open to all during the period and there will be the other events such as the Exposition of Science and Industry, the Biologists' Smoker, etc. Registration is $2.00 for members, $3.00 for others and the registration card admits to everything, but does not pay for dinners.—J. A. S.

Book Reviews

Bernhard Eduard Fernow: A Story of North American Forestry. By Andrew Denny Rodgers, III. 623 pp. Princeton University Press, Princeton, N. J. 1951. $7.50.

Bernhard Eduard Fernow is a biography that touches only lightly on the personal life of Dr. Fernow, but deals exhaustively with his contribution to the development of forestry in North America.

Dr. Fernow was born in Prussia in 1851. A descendant of German aristocrats, he studied law at the University of Koenigsberg and forestry at Muenden forest academy. But on coming to the United States in 1876, he found little opportunity for the practice of forestry and was employed for a while in a New York law office and later as manager of an iron furnace in Pennsylvania. However, he studied forest conditions at every opportunity, took an increasingly important role in writing and speaking, and with the aid of influential friends gradually created a forestry position for himself.

In 1886 Dr. Fernow became head of the Division of Forestry of the United States Department of Agriculture. During his 12-year tenure several important changes occurred—forest reserves were created; authority for beginning the rational administration of these was provided; and a start was made in forestry research. The last included studies of timber physics by Roth, monographs on a few of the most important tree species, and Sudworth's work on nomenclature.

But Dr. Fernow was not a money raiser nor a politician, and seeing the need for trained foresters, he left the Division in 1898 to start the New York State College of Forestry at Cornell. A part of this undertaking was the establishment of a demonstration forest in the Adirondacks to show proper methods of management. The difficulties encountered, the opposition of camp-site owners, resulting suspension of the college in 1903 and later litigation are fully and fairly discussed. In the spring of 1907 Dr. Fernow started the instruction of forestry at Pennsylvania State College and the following year at the University of Toronto where he remained until his retirement in 1919.

Throughout his life Dr. Fernow engaged in a multitude of activities to further the cause of professional forestry. He helped in organizing the Canadian Society of Forest Engineers, for a while was president of that society and of the Society of American Foresters, founded the *Forestry Quarterly* in 1902 and remained its editor-in-chief until after it became the *Journal of Forestry*. Pioneering in forestry, he developed wide interests and his writings and speeches dealt with all phases—soils, taxonomy, physiology, ecology, silviculture, protection (from fires, insects, and diseases), planting, timber physics and chemistry, etc. But Dr. Fernow continually emphasized the importance of properly managing the areas that were or should be devoted to forests, and insisted that the establishment of new stands of the proper composition was the forester's main business.

Mr. Rodgers must have spent a great amount of time and effort in preparing this book. The actions, thoughts, and ideals of Dr. Fernow are carefully portrayed. Described also are (1) the situations that prevailed at the time of Dr. Fernow's actions, (2) developments in all phases of forestry, and (3) the activities and personal histories of all persons having a prominent role in the development of forestry between 1875 and 1920.—SILAS LITTLE, JR., Lebanon Experimental Forest, New Lisbon, N. J.

Native Orchids of North America North of Mexico. By Donovan Stewart Correll. xvi + 399 pages; 7 figs.; 146 plates and frontispiece. The Chronica Botanica Co., Waltham, Mass. and Stechert-Hafner, Inc., New York. 1950 (1951). $7.50.

Among the rash of books that have appeared in the last few years in America to take advantage of the enthusiasm shown for orchids this is one of the best and most scholarly.

Dr. Correll is well prepared to write on the orchids of temperate North America. He has spent a number of summers observing the plants in the field and perhaps has devoted more time to their study in the herbarium than has any other botanist.

The volume apparently was prepared with two kinds of people in mind. First the amateur who wishes to know what the plant is and, second, the professional who needs an accurate and complete work. This book fills both needs amply. In most cases the amateur will need to go no farther than the illustrations to determine what he may have in hand. The text is as simply written as it is possible to do and still retain scientific accuracy.

The systematic work is carefully done and in most cases conservative. It will serve as a solid base for the taxonomy of temperate North American orchids for years to come. Cultural notes, distributional data, common names and general observations will be welcomed by many people.

Each entity in the volume is illustrated by a plate. Most of the plates were prepared by Blanche Ames Ames and by Gordon Winston Dillon,—in the opinion of this reviewer the two outstanding botanical artists in America. The volume is interesting also in that it follows the artistic career of Mrs. Ames as a botanical artist. There are many of her

illustrations made as early as 1903, the latest one is dated 1949. The technique and artistry change with the years, from such simple illustrations as that of *Habenaria hyperborea* to the work of art which forms the frontispiece of the volume.—LOUIS O. WILLIAMS, Escuela Agricola Panamerica, Tegucigalpa, Honduras.

The Cacti of Arizona. By Lyman Benson. Second Edition. 134 + xiii pp. and 29 plates. Illustrated. The University of Arizona Press. 1950. $4.00.

An easterner who has never seen the southwestern deserts is hardly an authority for a review of the above title. But the promptness with which the first edition sold out, the long experience of the author in field and herbarium studies at various places in the southwest, and his earlier taxonomic papers seem sufficient guarantee of the technical adequacy of this book.

The author has expressed the hope "that the more common cacti may be recognized without resort to the keys" supplied. The sincerity of this aim is evidenced by 24 plates of black and white photographs of the habit or closeups of diagnostic features. Each plate has one to nine photographs, all of them excellent both from the standpoint of photography and reproduction. There are 18 Figs. of line drawings by Lucretia Hamilton, most of them a whole page in extent and comprising several drawings. Another 15 Figs. are devoted to distributional maps of Arizona. Many people will be most delighted with the five plates in full color which illustrate *Cereus giganteus, C. Thurberi, Opuntia basilaris, O. Engelmannii, Echinocereus Engelmannii, E. triglochidiatus* var. *melanacanthus,* and *Echinocactus Wislizenii.*

The five genera are broken into 61 species as follows: *Opuntia* 26 (51 pages), *Cereus* 5 (10 pages), *Echinocereus* 5 (14 pages), *Echinocactus* 14 (20 pages), and *Mammilaria* 11 (18 pages). Four species have sufficient varietal representation to warrant special treatment in the form of tabulated diagnostic data. Although the distributional maps are of Arizona only, more complete data on geographical and altitudinal range are given in the text. Synonomy in nomenclature and intermediate form types are discussed where appropriate. Each species is also dealt with ecologically. The genus *Coloradoa,* for the mesa verde cactus, is excluded by implication—"Probably but not certainly a species of *Echinocactus.*" This species is not presently known from Arizona but, "to be expected in . . . the vicinity of the Four Corners."

A seven page chapter is devoted to "Culture and Care of Arizona Native Cacti." There is no index but one is hardly necessary.—JOHN A. SMALL.

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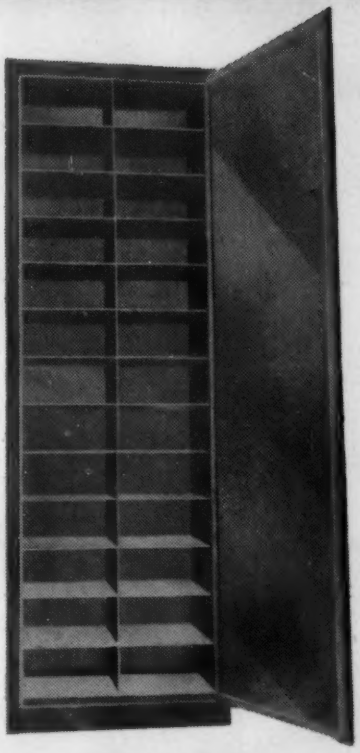

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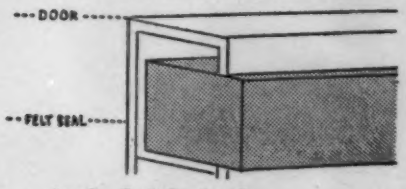

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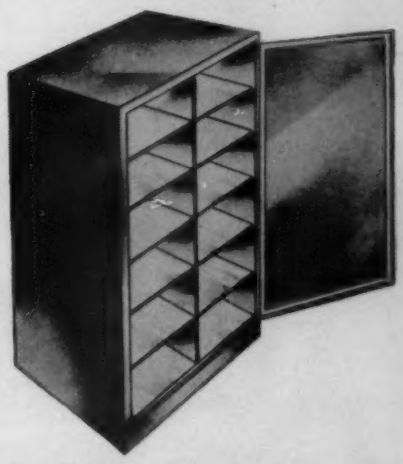

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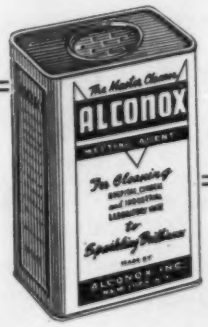

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